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THE STUDY OF VIDEO GAME DESIGN AND THE IMPLEMENTATION OF A GAME USING 3DGAMESTUDIO

by
Avrom Pancer

A thesis submitted in partial fulfillment of the
requirements for the degree of

Masters of Computer Science

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ABSTRACT

THE STUDY OF VIDEO GAME DESIGN AND THE IMPLEMETATION OF A GAME USING 3DGAMESTUDIO

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This thesis will explain how to design and program a game using 3DGameStudio. It will include topics on how to design the level using a three dimensional level editor and how to program the game using a c-based scripting language. It discusses the basic artificial intelligence and special effects required for a high-quality three dimensional game.

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Introduction

To create a 3D game we need three components: levels, models to put into the levels, and some sort of programming language to make everything run. 3DGameStudio has all of these components.

3DGameStudio, which is based on the Acknex game engine, is comprised of three programs: a model editor called MED, a level editor called WED, and a script editor called SED. By using all these three components together you will be able to create almost any kind of 3D game.

If you prefer to program in C++ instead of using the script editor 3DGameStudio allows you to manipulate almost anything in your game using their C++ SDK. This allows an experienced programmer the ultimate flexibility to create the perfect game.

3DGameStudio allows you to import levels, models, sprites, and maps from numerous other programs; this allows game designers to use programs that they are already familiar with.

Like C++ and Java, 3DGameStudio is based on an object oriented methodology. Each entity, block, or group of blocks is considered an object. These objects can be used over again and over again by simply copying and pasting them. So if you have a hallway or room that you want to duplicate you simply copy it instead of rebuilding it from scratch.

The game engine is the core of the development system. It generates the 3D images and controls the behavior of the virtual world. Due to its combined BSP-Tree and terrain renderer, 3DGameStudio's engine handles indoor and outdoor sceneries equally well. It has a lighting engine that supports true shadows and moving light sources. The threefold culling algorithm renders huge worlds of 100,000s of polygons with over 70 fps even on old hardware. Programmers can use the plug-ins for adding new effects and features.

3D Engine[1]

- Six degrees of freedom, multiple cameras and render views
- Supports DirectX 9, DirectPlay, DirectShow, DirectSound
- Window or full screen mode
- BSP/PVS, Portal and frustrum culling
- Geometric LOD and trilinear mip mapping
- Static and dynamic point, spot, and directional light sources
- Static and dynamic shadows
- Colored fog areas
- Portals and mirrors
- Vertex and pixel shaders, HLSL/Cg and asm shader languages
- Bump and environment mapping
- Multitexturing (up to 8 textures), light maps, detail textures
- Material properties for static and dynamic objects
- Animated 3D sprites and decals
- Seamless indoor and outdoor support with deformable multitexture terrain

[1] Specs for 3DGameStudio was obtained from http://conitec.com/a4info.htm

- Models with mesh deformation, bones and vertex animation, animation blending
- Programmable particle and beam generators
- Sky system with animated layers and backdrop bitmaps
- 2D renderer for still images, 2D sprites, panels, buttons, sliders, overlays, True type and bitmap fonts, screenshots and movies
- 3D views and movies can be rendered to curved surfaces, for distortion or fisheye effects
- Programmable 2D and 3D effects like lens flares, bullet holes, cartoon rendering etc.

Game Engine

- Polygon level collision detection
- Physics engine supports gravity, damping, elasticity, friction, and hinge, ball, wheel, and slider joints
- 3D sound sources (WAV and OGG) with Doppler effect
- Slow motion / quick motion effect
- Arbitrary axis rotations for space and flight simulators
- Path tracking for camera, actors or vehicles
- Mouse picking and manipulating of 3D objects
- Save / Load system for resuming games at arbitrary positions
- Multi-player client/server mode for LAN and Internet (TCP/IP, UDP)
- Multizone/multiserver support for massive online multiplayer games
- Expandable through DLL plug-in interface

We will be going through the functions of each of the three programs in this package. This will give you an idea of what each program does and how each function works. With the information obtained from this thesis you will be able to produce commercial games using this software package.

Before you start creating your 3D game you must first plan out exactly what the object of the game will be and how you want it to look.

After you figure out what your game is about, in most cases you will want to start with the level editor, WED. With this program you will design the levels for your game. You will create rooms, hallways, doors, etc. After you created the level you will then go to the model editor program, MED. With this program you will create the characters and moving objects of the game. You will then go to the scripting program, SED. With this program you will write a program to control everything in the game. Finally, after everything is complete you go back to the WED place everything that you created in MED in the proper places in the level, assign the programming code from SED to all the different parts of the level, then you compile the program and run it.

The above scenario usually doesn't happen; in most instances you will be switching from program to program tweaking code, editing models, and adding and changing levels.

To create a good fully functional 3D game takes a lot of time, patience, and creativity.

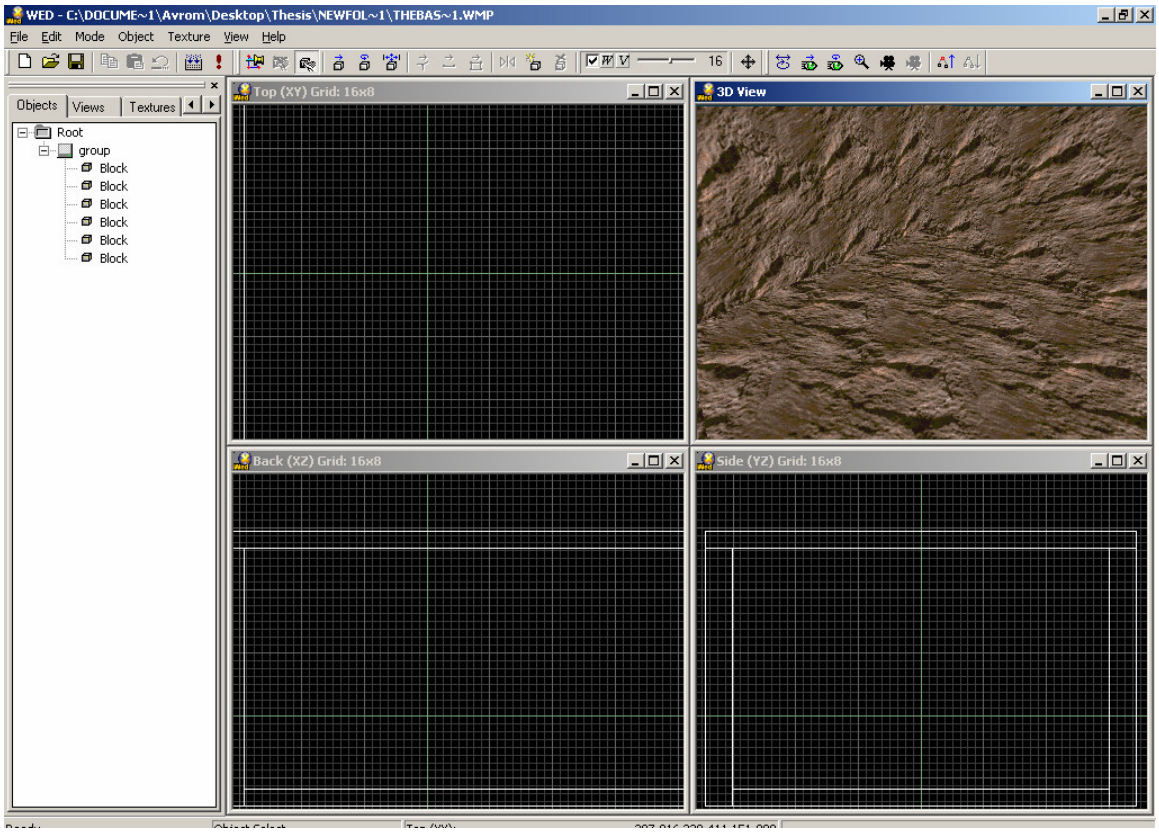
Chapter 1
The Basics

Introduction

In this chapter we will go through the basic steps to create a game. You will get a feel of how each part of 3DGameStudio functions.

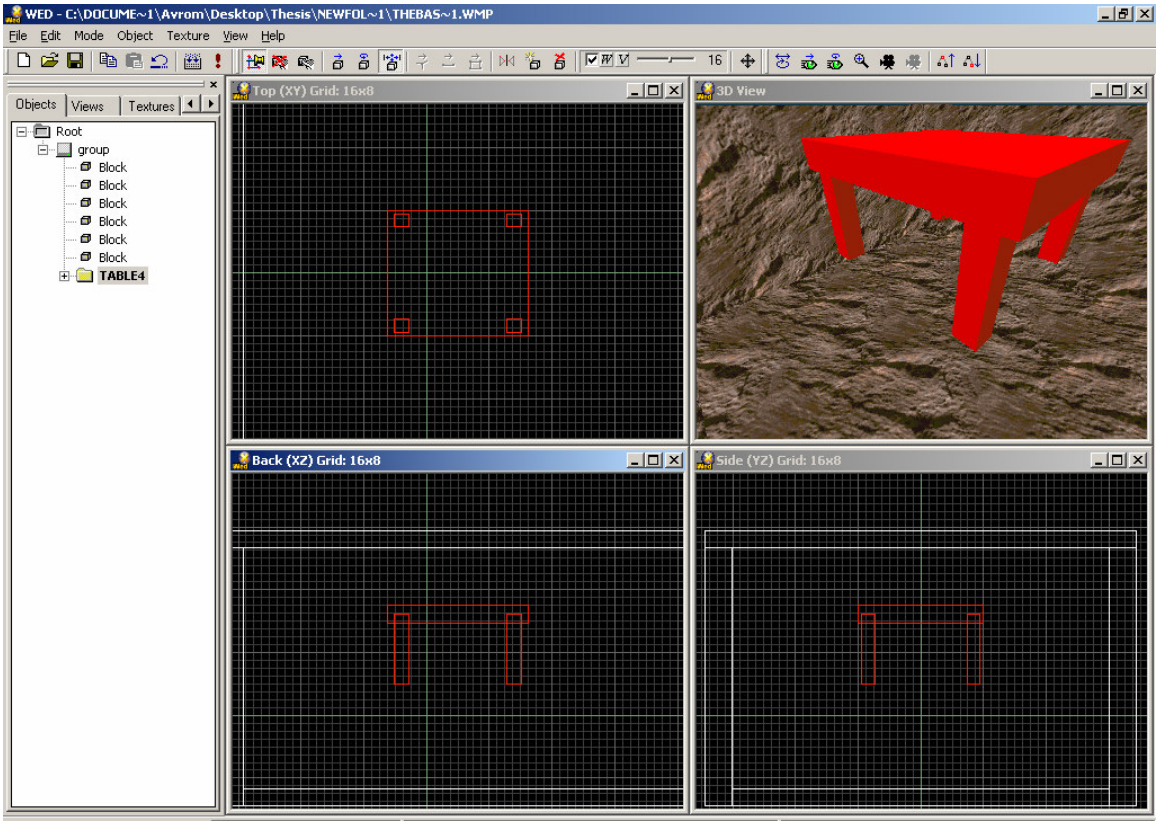
First Program

I have included a folder called "The Basics"; this is just to get you started. In Chapter 2 we will go through how to create a new level from scratch. Inside the folder there are a few files, double click on the one called .TheBasics.wmp", this should open the WED program. Your screen should look like this:

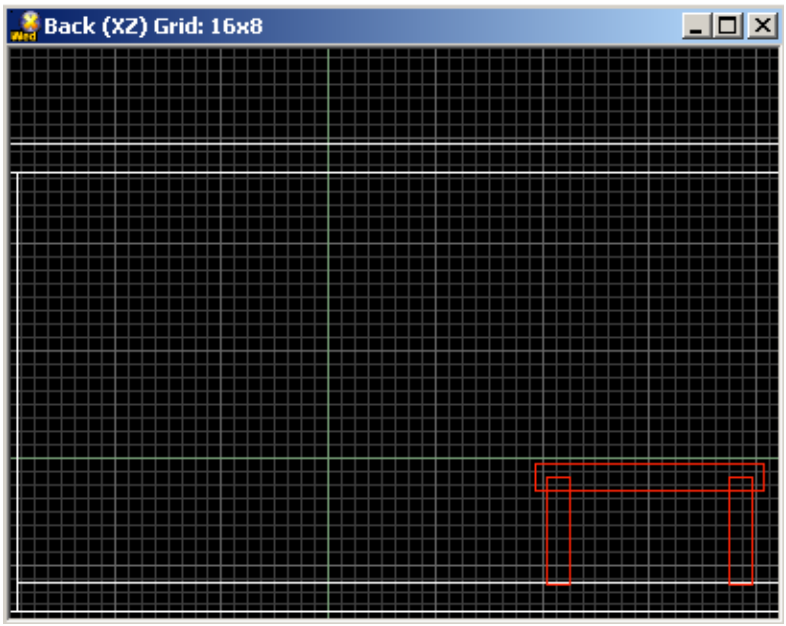


The file "TheBasics.wmp" is a file that I created, all it has right now is a hollow cube that has a stone texture. This will be the room for our small project. Now we will add a table; click on "Object" which is on the icon bar and then click on "Add Prefab", this will open the "Add Prefab" browser. On the left side of the browser click on "FURNITUR", on the right side there will be a list of different furniture that you can add to your level, click on "TABLE4" and click "OK". You will now see a small red table in middle of your screen. On the icon bar click on the "Lock Selection" button and then on the "Scale" button. Now click on the red table in the top view and drag the cursor

and make the table bigger; then in the back view do the same thing. Try to make your table look like this:



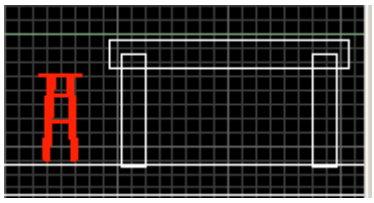
Now click the "Move" button and in the back view drag the table to the lower right and corner and line it up to the floor like this:



Now on the icon bar click “Build”, click “OK” and then after the level is built click “OK” again. Click “Run” and then “OK”. You should see a room with a wooden table in it. You can move around using the mouse and the arrow keys. After you are finished moving around the level hot the “Esc” key to exit.

Now we will put a stool model into the room. First let’s open the model editor, MED; we will not be creating any models we will just get the feeling of the program. Click on “File”, “Open”, and in “TheBasics” folder double click on “stool”. This layout looks almost the same as the WED layout. Model editing is its own component of game design and we will not be going into it with much depth. Also the MED editor is not a very powerful program and most model designers will use other programs such as 3DStudioMax to create models. Once the model is created it can be imported into MED and be converted into an .mdl file so it can be used with 3DGameStudio. Another problem with MED is its skin editor; click on “View” and then “Skins”, this is the skin editor. You will notice that the skin looks wavy; this is because it’s a 2D representation of a 3D object. For this reason most model designers use graphic programs such as PaintShop Pro to create skins for their models. Close the MED and do not save any changes.

Back in WED click on “Object” then “Load Entity” and then double click on “stool”. You should now see a small red stool in the center of the room. Now click on “Scale” and in the back view drag the stool and make it bigger, then click on the “Move” button and move the stool to the table. Try to make it look like this:



Build and run the level again, as expected you see a table and a stool, now exit the level.

Now for the fun part, we will write a script to move the stool. Click on “File”, “Map Properties”, “New Script” button, select “Empty Script”, click “OK”, and then close the Map Properties box. On the left side of the screen you will see the Project Toolbar click on the right arrow until you see the Resources tab, then click on it.

Click on the “+” next to “script files” and then double click on “THEBAS~1.wdl”, this will open the C-Script Editor, SED. Copy and paste the code below into SED.

```
var video_mode = 8; // sets screen size 1024x768
var video_depth = 32; // sets colors to 32bit (16.7 million)
var video_screen = 1; //full screen

function main()
{
	level_load("TheBas~1.wmb"); // loads new WMB level
	wait(3); //wait for level to load
}

action stool
{
	//my is the current entity; in this case it is the stool.
	my.narrow = on; // next three lines is used for collision control
	my.fat = on;
	c_setminmax(my);

	while(1)
	{
	//if up arrow key is pressed
	if(key_cuu == on){
		//move stool up with collision control
		c_move(my,vector(0,0,2*time),nullvector,glide);
	}

	//if down arrow key is pressed
	if(key_cud == on)
	{
		//move stool down with collision control
		c_move(my,vector(0,0,-2*time),nullvector,glide);
	}

	//if right arrow key is pressed
	if(key_cur == on)
	{
		//move stool to the right with collision control
		c_move(my,vector(0,2*time,0),nullvector,glide);
	}

	//if left arrow key is pressed
	if(key_cul == on)
	{
		//move stool to the left with collision control
		c_move(my,vector(0,-2*time,0),nullvector,glide);
	}
```

```
        //if the a key is pressed
        if(key_a == on)
        {
                //move stool foward with collision control
                c_move(my,vector(2*time,0,0),nullvector,glide);
        }

        //if the z key is pressed
        if(key_z == on)
        {
                //move stool backward with collision control
                c_move(my,vector(-2*time,0,0),nullvector,glide);
        }

        //if the r key is pressed
        if(key_r == on)
        {
                //rotate the stool with collision control
                c_rotate(my,vector(0,2*time,0),glide);
        }

        // wait for one frame cycle, this allows other function to run.
        //must be used in every while-loop
        wait(1);
        }
}
```

Click on “Save” , then click on “Configuration” . In the Configuration window under “CSC/WDL file to run” click on , then in “The Basics” folder double click on “THEBAS~1”, and then click “OK”. Back in the main screen of SED click on the “save” button and close the SED. Go back to the WED, right click on the stool, click on “Behavior”, select “stool”, and click “OK”. Now build and run your level again. Try pressing the arrow keys and the “a”, “z”, and “r” keys; you will see the stool moving and rotating in different directions. (If you are too close you can hit the “0” key and use the arrow keys, the mouse and the mouse buttons to move around the level; once you have a good view hit the”0” key again.)

This is our first program; it is very simple but it introduces the major parts of the 3DGameStudio package.

Chapter 2
World Editor / Level Editor
WED

Introduction

WED is the editor used to create a level or levels for your game. With this editor you create the actual level and add the models created in MED and scripts created in SED. WED compiles and generate the BSP tree for the Acknex game engine.

WED has the following features:

- Object oriented grouping and scoping
- Object move, rotate and scale manipulations
- Prefabricated block objects
- Block vertex, edge and face manipulations
- Block hollowing and subtraction
- Undo operations
- Entity property editing
- Wire frame / Solid Polygons / Texture previews
- Easy map navigating interface
- Texture bookmarks
- Texture move, rotate and scale manipulations
- Multiple texture files manager
- Compiling WMB files and running the engine from within the program
- Publishing the game or application (not available in the academic version)

We will go through all of these features and explain each one and how to use them to create a great looking game level(s).

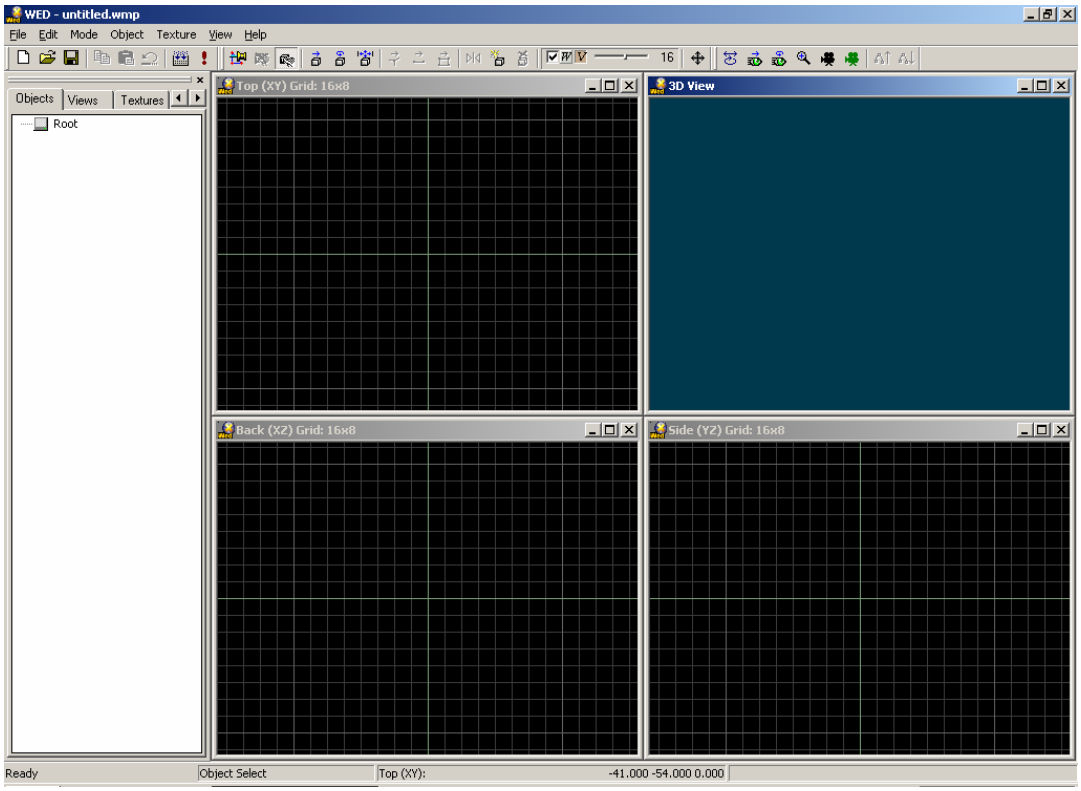
Basic Theory of Level Editing in 3DGameStudio

There are two kinds of objects that can be placed in the level either a block or an entity. A block is pretty simple to explain, as by its name it's a basic building block consisting of six sides. An entity on the other hand is a little more complicated. It can be a terrain, model, map or sprite. A short explanation of each is as follows. A terrain is textured rectangular grid of height values; this is used as a landscape. A model is an animated 3D object, such as a person, monster, etc. Both of these are created in MED. A map is a 3D object made up of many blocks; this can be used to create doors, elevators, etc. This is created in WED. A sprite is a 2D object; it can be a picture on a wall, used for lights, explosions, etc. It is not important right now that you fully understand what each item is it will be explained in greater depth as we cover each topic.

User Interface

We will now start going through the WED's user interface and each of its function will be explained. We will start by opening up the WED program. You should see a plain grey screen. Make sure to maximize the screen by clicking the maximize button on the upper right had corner of the window. This way you will be able to use as much room as possible for editing.

Click File on the menu bar and select New. Your screen should now look like this.



Views

The four boxes on the screen each show you a different view of the level. The three black boxes with the grids are 2D, each showing a different side of the level, top, back, and side. The grey box is a 3D view of the level. You can add as many views as you like by clicking View on the menu bar and selecting Add View. In the beginning you will find it a little difficult to place objects precisely where you want them. After you learn how the four views display the objects you should have no problems.

Project Toolbar

On the left side of the screen there is a white box, this box is called the Project Toolbar. It has four tabs Objects, Views, Textures, and Resources. This toolbar keeps track of all the different components used in the game design. We will be using this toolbar throughout the game design and all its functions will be explained.

Icon Bar

We will now go through the buttons on the icon bar. Most buttons that are on the icon bar have a keyboard shortcut. You can view them by clicking on File on the menu bar, click on Preferences, and then select the Key tab. You will see a list of Commands in the Command List box. By clicking on the command you will see the current shortcut and then you can assign a new shortcut. For example, when you click on undo you will see that the current shortcut is Ctrl+Z, so whenever you press Ctrl and then Z together in WED it will undo the last action that you did. If you don't like the current shortcut you can change it by clicking in the New Shortcut box and typing in the shortcut that you prefer. As we go through the different commands I will add in parentheses the default shortcut for that command.

There are many ways of doing each command, as we go through the commands I will be using different methods for the same commands and you can pick which ones work best for you.

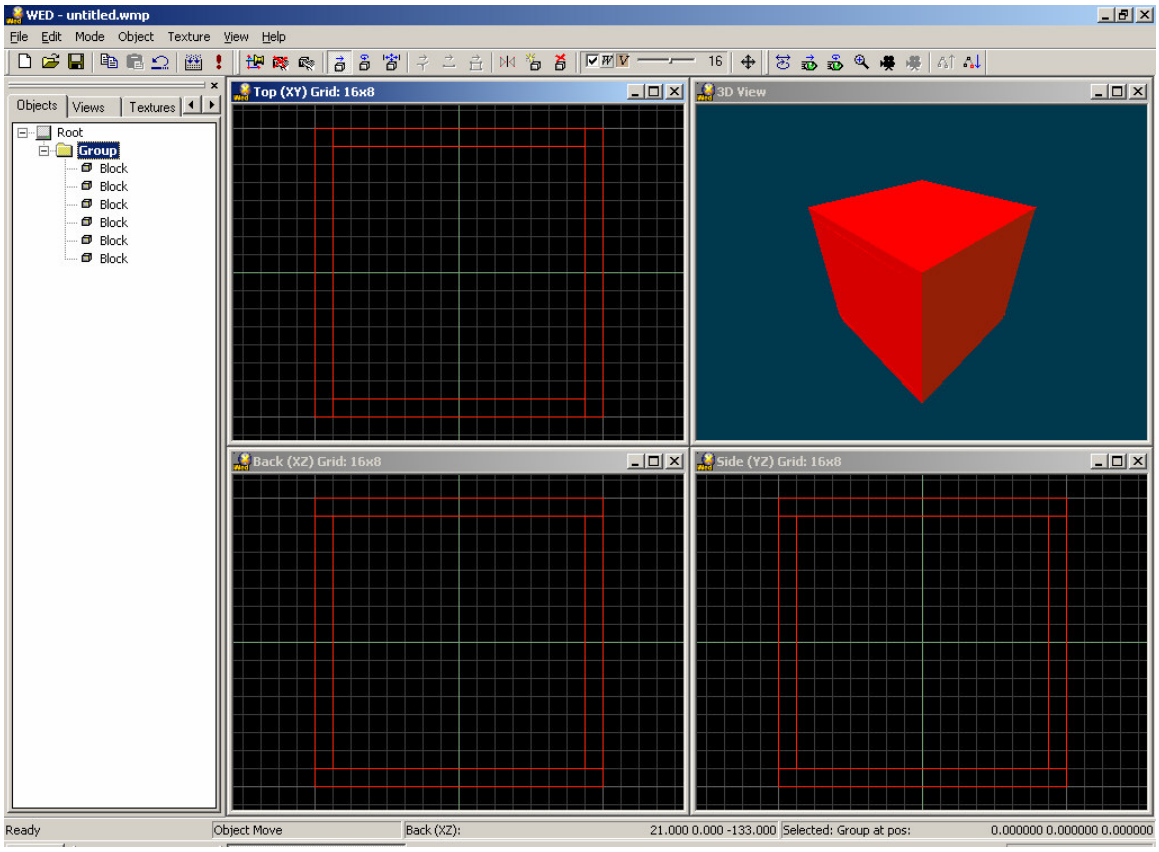
New – Open – Save

The first three buttons, are simple, they are the same as many programs. The first creates a new empty level, the second opens an existing level from a file, and the third saves the current level. Click Save and give your project a name and save it. Before you start each step you should save your project so if you do something wrong and you can't reverse it you can just close the project without saving and then reopen it to the last saved spot.

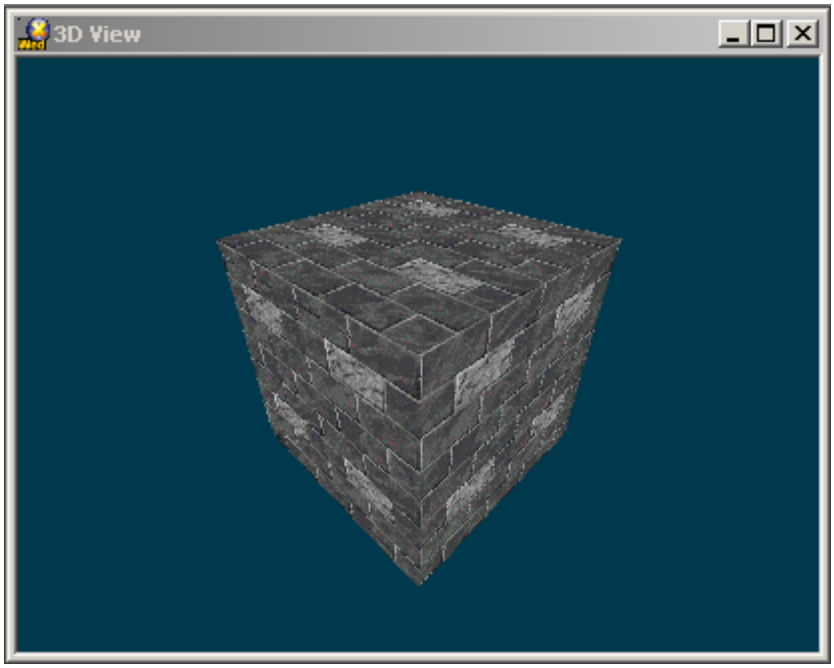
Copy – Paste – Undo

The next three are also standard in most windows programs. The first copies whatever is currently selected and places it into the clipboard (Ctrl+C), the second pastes whatever is in the clipboard (Shift+Insert), and the third undoes the last action.

You should already have an empty new project opened (if you didn't, click on the first button of the icon bar). We will start by adding a hollow cube. Click on Object place the mouse over Add Hollow Cube and then select Large. You will notice in the Project Toolbar that a group was added. Click on the + sign next to Group. Your screen should look like this:



You will notice that in the Project Toolbar under group there are six blocks. This is because a hollow cube consists of six sides. Each block is a side of a cube and the group is the complete cube. Now look at the four views. The three 2D views show the different sides of the cube and the 3D view shows the cube in 3D. Click anywhere in any of the views outside of the cube. You will notice that the cube will turn white. This is because the cube is not selected anymore. When an object is selected it will be red otherwise it will be white. You can select multiple objects and apply single command to all of them. We now have a plain untextured cube in our level. We must add a texture to the cube in order to compile a level. Click on View and select Textured (F7), this allows the 3D view to display a textured picture. Now click on Textures tab in the Project Toolbar. You will notice under default.wad a basic brick texture. Select the cube and double click on brick texture. Now unselect the cube. In the 3D view you will see the cube look like this:

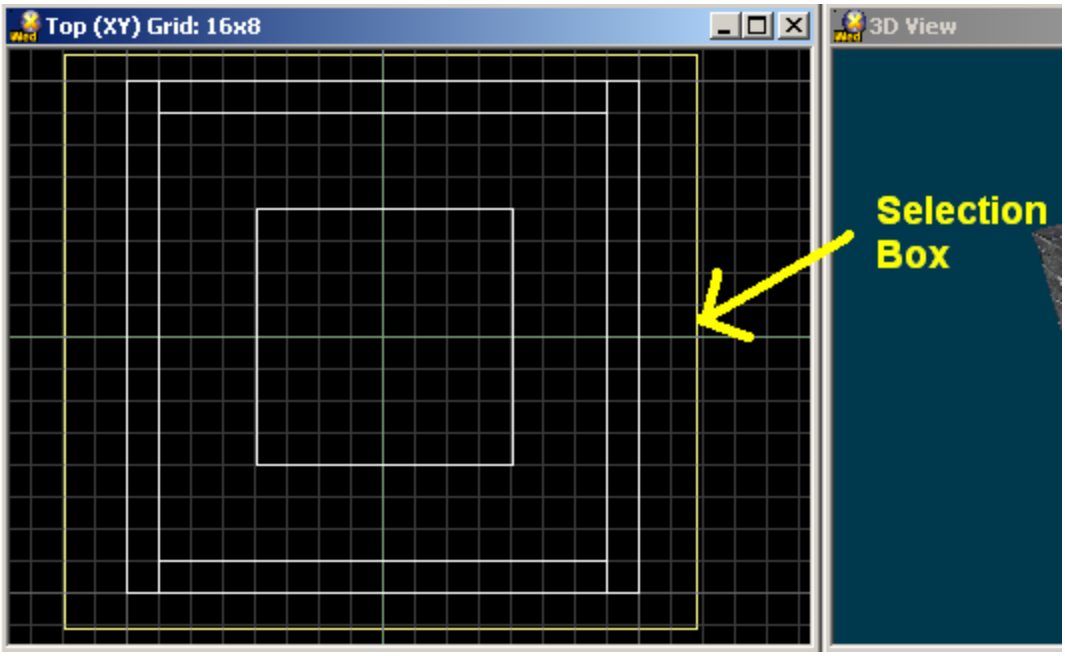


Build – Run

The next two buttons, the first button builds the level and the next one runs it. We will now compile the level and run it. Select the build button, Select Build Level, and then click OK; you will see the level being compiled. After the level has been compiled click OK. Next click the Run button and click OK. You should now see a brick wall. You will be able to rotate the camera by moving your mouse. You can move forward by using the right mouse button. You will notice that you can move through the walls, this is because there is no script controlling anything in the level. All you are controlling now is a default camera moving around the level. To exit the level hit the Esc key. Another thing worth noting is that if we inserted a cube instead of a hollow cube we would not have been able to see anything inside the cube. The reason for this is because the cube would have been a solid mass consisting of a single block instead of the six we have now.

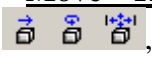
Lock Selection – Select None – Select

The next three buttons has to do with object selection. The first is Lock Selection, the second is Select None, and the third is Select. To understand how they work we have to add another object. Right click in the center of any of the 2D views, place the curser over add, then over add cube, and then click on medium. You should now see another cube in the center of your screen. Now click and hold on the upper right hand corner of any of the 2D views. Drag the curser to the lower left hand corner of that view. As you start dragging the cursor you will see a selection box, make sure that the box encloses both cubes.

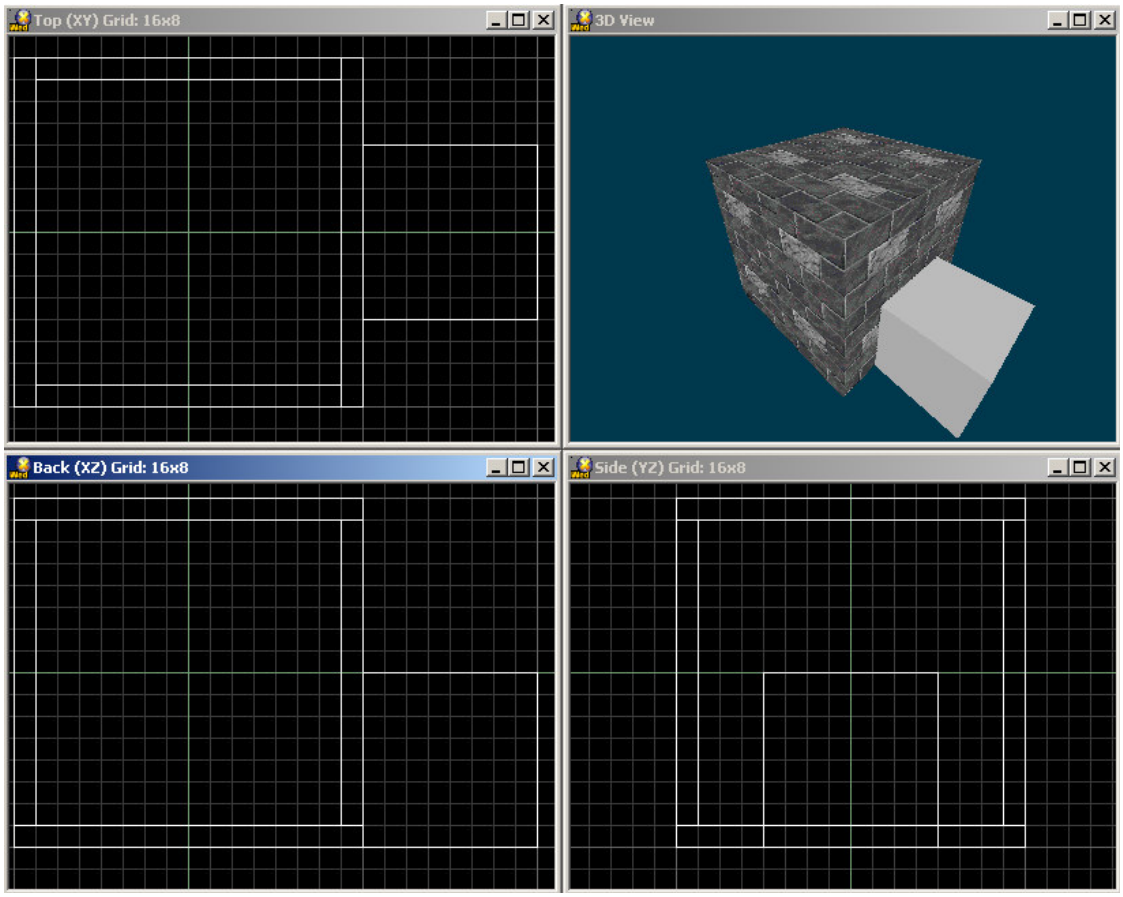


If you are having trouble selecting both cubes you can move around the view by right clicking and holding anywhere in the view then drag the cursor. After both cubes are selected click on Lock Selection. Now try clicking anywhere on any of the views. You will notice that the two cubes always stay selected; this is because Lock Selection is enabled. This feature is useful when manipulating a group of objects, if you accidentally click somewhere on the screen you wont loose the selection. To continue we first must disable the Lock Selection. Now click on the Select None button, as you would expect it deselects both cubes. This button works even if Lock Selection is enabled. Next button, Select, changes the mode to Selection Mode, it is used to make selecting object easier. Click on Select; now click in the center of any of the 2D views. You will see that the hollow block is selected, click again and the solid cube will be selected. Each time you click it will cycle through the cubes that are under the cursor. This is a standard feature that can be used in any mode. Click on Select None, and then click on the center of any of the 2D views. The hollow cube will be selected. Hold down Ctrl and click on the center of the view again, now both cubes are selected. This feature is used when you want to select multiple objects that are at different places in the world.

Move – Rotate – Scale

The next three buttons,  , have to do with object manipulation. The first is “Move”, the second is “Rotate”, and the third is “Scale”. We will start with “Move”; this function moves any object that is on the WED. Select the medium cube and then click “Move”; this will set the program to “Move Mode”. In the top view click and hold the cube, drag in to the right, and line it up with the side of the hollow cube. While you are moving the cube watch the 3D view and see what you are doing. Since you are moving the cube in the top view, when you move it up and down you will see in the 3D

view that you are really moving it right to left. Now click on the medium cube in the back view and drag it down to be level with the hollow cube.



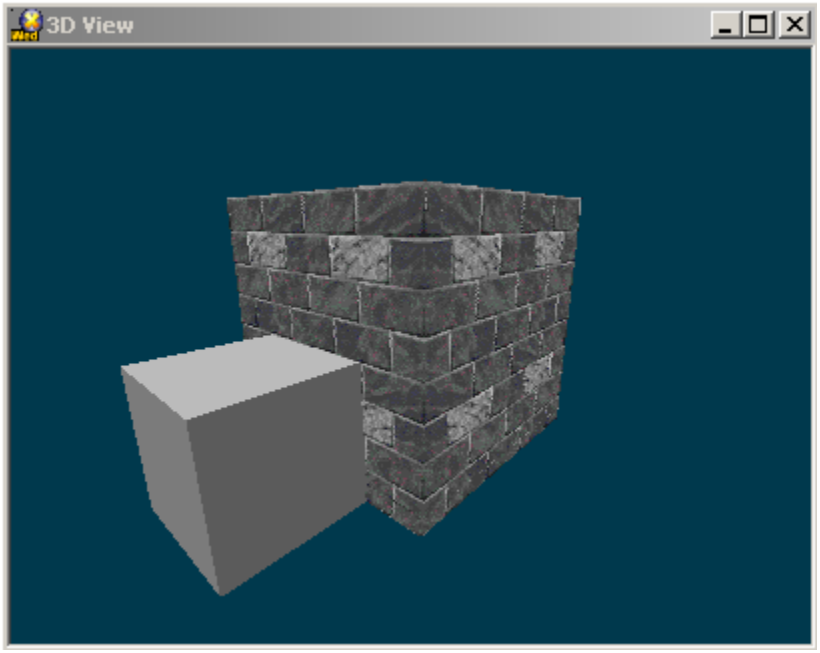
The next function “Rotate” rotates any object in the WED. Click on “Rotate”, this will set the program into “Rotate Mode”. In the top view click and hold the hollow cube, drag the cursor either right or left while watching the 3D view. Do the same for the other two 2D views and the other cube. You will see that each view rotates the cube on a different axis. After you finished with the rotations and have a basic feeling how it functions make sure that you place the cubes back to the way they were.

Save your project before continuing. The next function “Scale”, scales any object in the WED. This function is limited to scaling at 2D at a time; this limitation limits confusion while scaling. Click on “Scale”, this will set the program to “Scale Mode”. Click on a cube in any of the 2D views, and drag the cursor. Depending on which way you drag it that is how the cube will be expand or retract. As in the rotations try it in all the 2D views while watching the 3D view. You should also note that the width of the walls in the hollow cube change when you scale the cube. This will be important later on when we make doorways between rooms. If you hold down Ctrl while scaling it will scale proportional; this means the original ratio of all six sides will be kept. Try to make the cubes back to the way they were. If you can’t, close the project without saving and

reopen it; if you saved it right before you started scaling the cubes, they should be back in the correct positions.

Vertex Move – Edge Move – Face Move

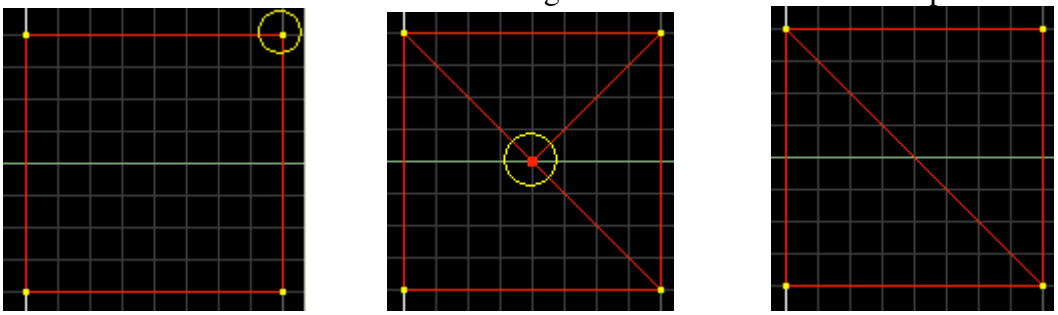
The next three buttons, , actually changes a block. The first is "Vertex Move", the second is "Edge Move", and the third is "Face Move". With the exception of "Vertex Move" these function only apply to solid blocks. (We will see later that "Vertex Move" can also be used with paths.) We will start with "Vertex Move"; this function is used to change the shape of a block by moving the vertices. To start we will set up the 3D view so we can see what we are doing when we change the cube. Click on (we did not cover this button yet) and rotate the cube in the 3D view by clicking and dragging the cursor. Try to make the view look like this:



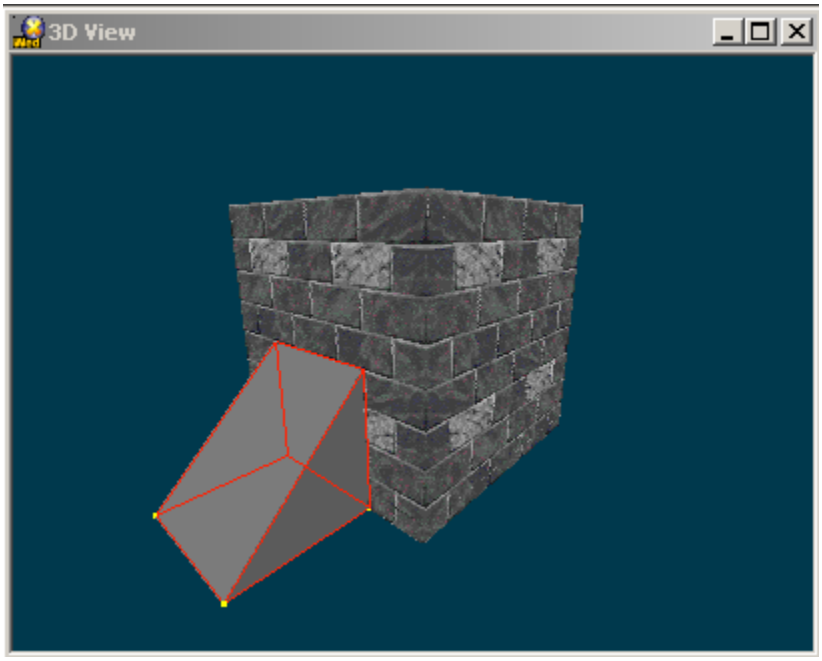
One more thing before we start with Vertex Move click on the "W"

on the icon bar until it turns to "D", this function will be explained later. In any 2D view select the solid cube and click on "Vertex Move"; you will see four yellow dots appear on each corners of the cube. To move a vertex simple click and drag a dot. The WED limits the cube manipulation that the cubes can not be concaved. If you concave a cube a warning will appear; if you click "OK" the cube will snap back to the original position, if you click "Ignore" the cube will stay in its current concaved form but you can end up with errors in the level. In the top view click on the upper right corner of the cube and drag it in the center of the upper left corner and the lower right corner thereby creating and triangle.

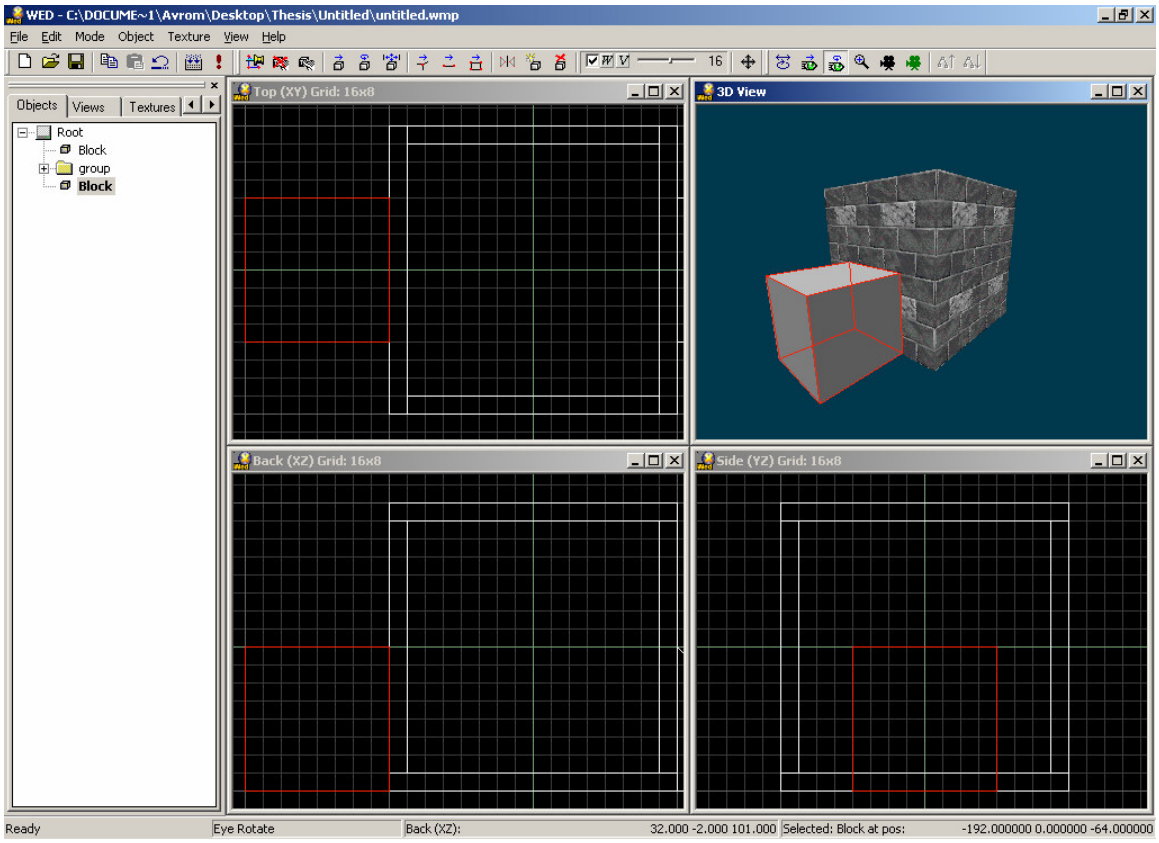
Click Drag Drop



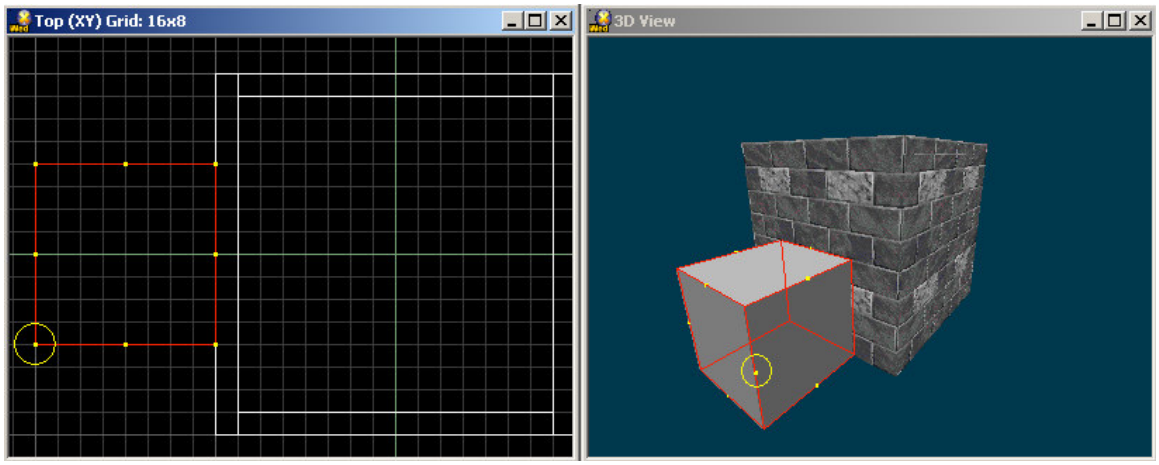
Notice that the edge disappears. Look at the 3D view and see what happened to the cube. Now do the same thing in the back view. The 3D view should now look like this:



Create another medium cube and place it on the other side of the hollow cube; then rotate the 3D view so you can see the cube you just created. Your screen should look like this:

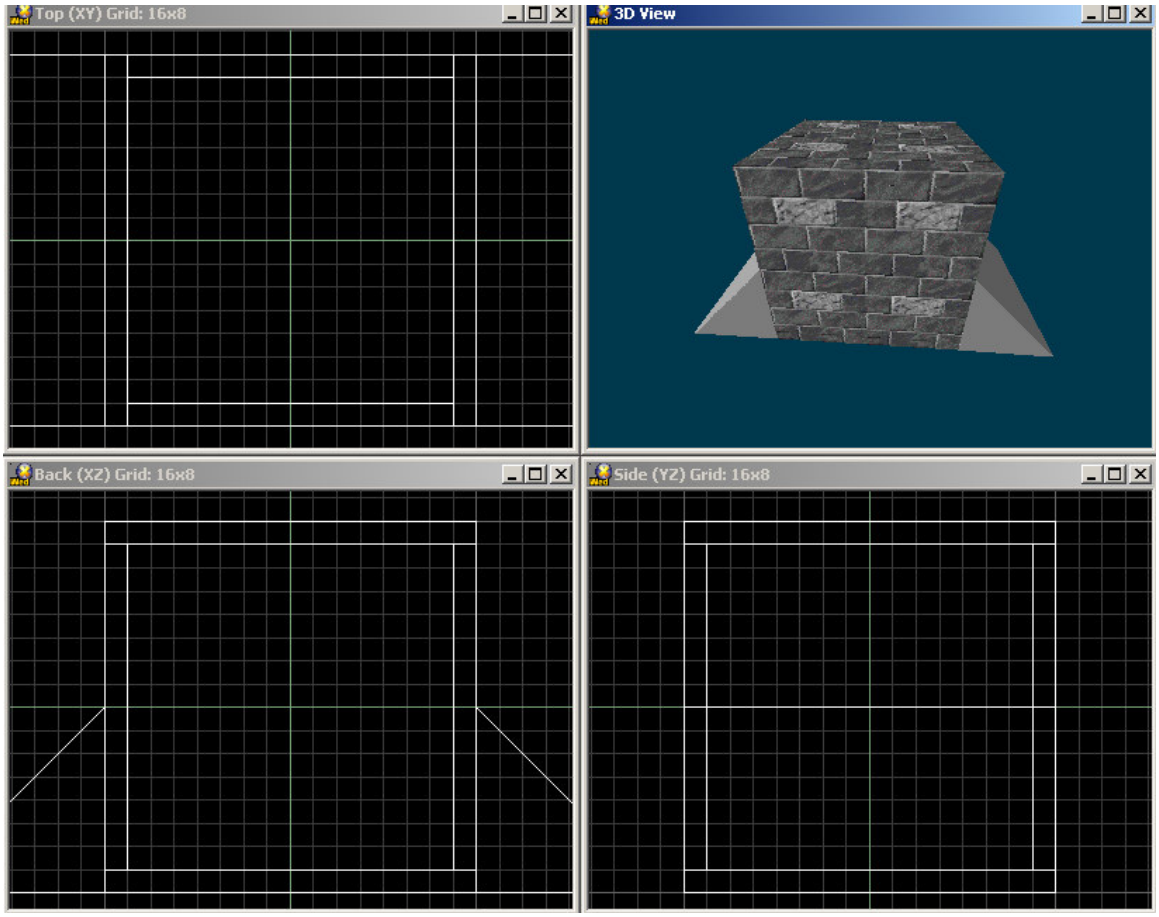


The Move Edge function is used to change the shape of a block by moving the edges. If the new cube is not selected select it now and then press “Edge Move”; this place yellow dot at the center of each edge. If you look in the 2D view it looks like the corners of the cube have a yellow dot on them; but if you look in the 3D view you can see that these are really on the edge of the side going down.



In the back view drag the upper left yellow dot in between the upper right and lower left yellow dots. Since we are moving the edge instead of the vertex the cube now looks like the first solid cube does but it only took on step.

The Face Move function is used to change the shape of a block by moving the face. Select the block we where just working on and click “Face Move”; this place yellow dots in the center of each face. In the top view click in the highest yellow dot and drag the face level to the hollow cube; do the same for the lowest dot. Repeat the Face Move steps for the block on the other side of the hollow cube. Your screen should now look like this:



“Mirror” – “Add Object” – “Delete Object”

The next three buttons, , are fairly simple; the first is “Mirror”, the second is “Add Object”, and the third is “Delete Object”. Let’s start with “Mirror”; this function flips the vertices on the X or Y axis. This function will do nothing on a cube, because when you flip a cube it still looks the same. Let’s start by selecting the right block (triangle) on the back view. You will notice that it turned upside down. Click the “Mirror” button again and it will return to its original position. Try this in the other 2D views and note each rotation; after return everything back to how they where. The next two buttons are simple. Clicking on the “Add Object” button a list comes up of what kind

of object you want to add (we saw this before when adding objects to the WED) and clicking on the "Delete Object" deletes the selected object.

Object "Snap"

The next buttons on the icon bar, , have to do with object movement. When we move two cubes together we want to make sure that there are no spaces between them. The reason for this is that even if there is just a one pixel space in the WED when the user plays the game there can be a noticeable gap. Also if the cubes are very close together but not touching the compiler takes longer to build the level. To prevent this spacing we use "Snap". The check box on the icon bar enables and disables the snap function. The next button toggles between "Delta Snap", "World Snap", and "Local Snap". "Delta Snap" only allows the object to be moved relative to its own origin, World Snap only allows the object to be moved relative to the level origin, and "Local Snap" only allows the object to be moved relative to the group origin. "Delta Snap" should also be used when using "Edge Move" or "Face Move", this makes it easier to manipulate the cubes. The next button, "Vertex Snap", when enabled snaps the object to the next vertex of another object in the same group. The slider bar controls how many quants the object is snapped to. A quant is a measurement used to measure the size of the level. The level is limited to 100,000 quants. The last button restricts the movement of an object. When set to the default an object can be moved in any direction, when set to right and left you can only move the object right and left relative to the view, and when set up and down you can only move the object up and down relative to the view. Try moving around the different objects in the level using the different movement functions and restrictions. Some of the "Snaps" might not make a difference, this is because the level is small and we don't have many groups. If something doesn't line up just right adjust the slider to a lower number. The move restriction button is great if you just want to move, resize, or manipulate an object in one direction without affecting the other direction.

Camera and Eye Movement

The next set of button on the icon bar has to do with camera and eye movement in the WED. These functions are used to give the game designer a better view of the level. All the 2D views when manipulated move as one and is independent from the 3D view. The first button, "Camera Move" has two functions. In the 2D views it allows you to move the view by left clicking and dragging the mouse. The same thing can be accomplished any time by right clicking in a view and drag the mouse. In the 3D view it rotates the whole view around with you being in the center. Next is the "Move Eye button"; in both the 2D views and the 3D view this function moves the level up and down right and left. The next button "Rotate Eye", in the 3D view it rotates the whole level on the x or y axis. This function does not do anything in the 2D views. Next button, "Zoom Eye", zooms in and out, this works in all views.

The next button, "Camera Position", controls where the 3D view eye is and where it is looking at. When you click the "Camera Position" button you will notice in the 2D views a red box and a yellow box connected by a red line. The red box is the position of the eye and the yellow box is the position then the eye is looking at. With this function in the 3D view you can rotate the world by right clicking and dragging and zoom in and out by left clicking and dragging. When you are doing this in the 3D view the red and green boxes will move in the 2D views. The next button, "Walk Through" takes you through the level in the 3D view without compiling the level. You move backward and forward using both mouse buttons and move the mouse to control the direction. To exit the "Walk Through" mode simple press "Esc", "Enter", or the space bar.

Scope

The last two buttons on the icon bar are "Scope Up" and "Scope Down". These functions make it easier to manipulate a group of blocks by isolating them from the rest of the level. Click on the "Hollow Cube" and select "Scope Up", all you should see now in the views is the "Hollow Cube", which is a group blocks. Now press "Scope Down" and the level will return back to normal.

Menu Bar

We will now go through the functions on the Menu Bar, most of the functions in the Menu Bar we have already covered previously when going through the Icon Bar and we will skip them.

File Menu

We will start by clicking on "File" and then "Map Properties", in "Map Properties" there are three tabs "Main", "Fog", and "Sun". Under the "Main" tab there are three settings "Nexus", "Palette", and "Script". The "Nexus is the size of the level; leave this unless there is a "Nexus too small" error during the build and in that case increase the size. "Palette" is generated during the build process and in most cases should not be changed. "Script" adds, creates, and removes c-script files from the level. (In a later chapter we will cover c-script.). Next is the "Fog" tab this controls the fog colors in the level. Fog in the level is controlled by c-script. The next tab "Sun" controls the universal "sun light" for the level. Using this feature it is easy to create skylights, shadows, etc. It has settings for the color, ambient, azimuth, and elevation.

"Starter", "Resources", and "Publish" are not available in the Academic Version; they are used to publish the game.

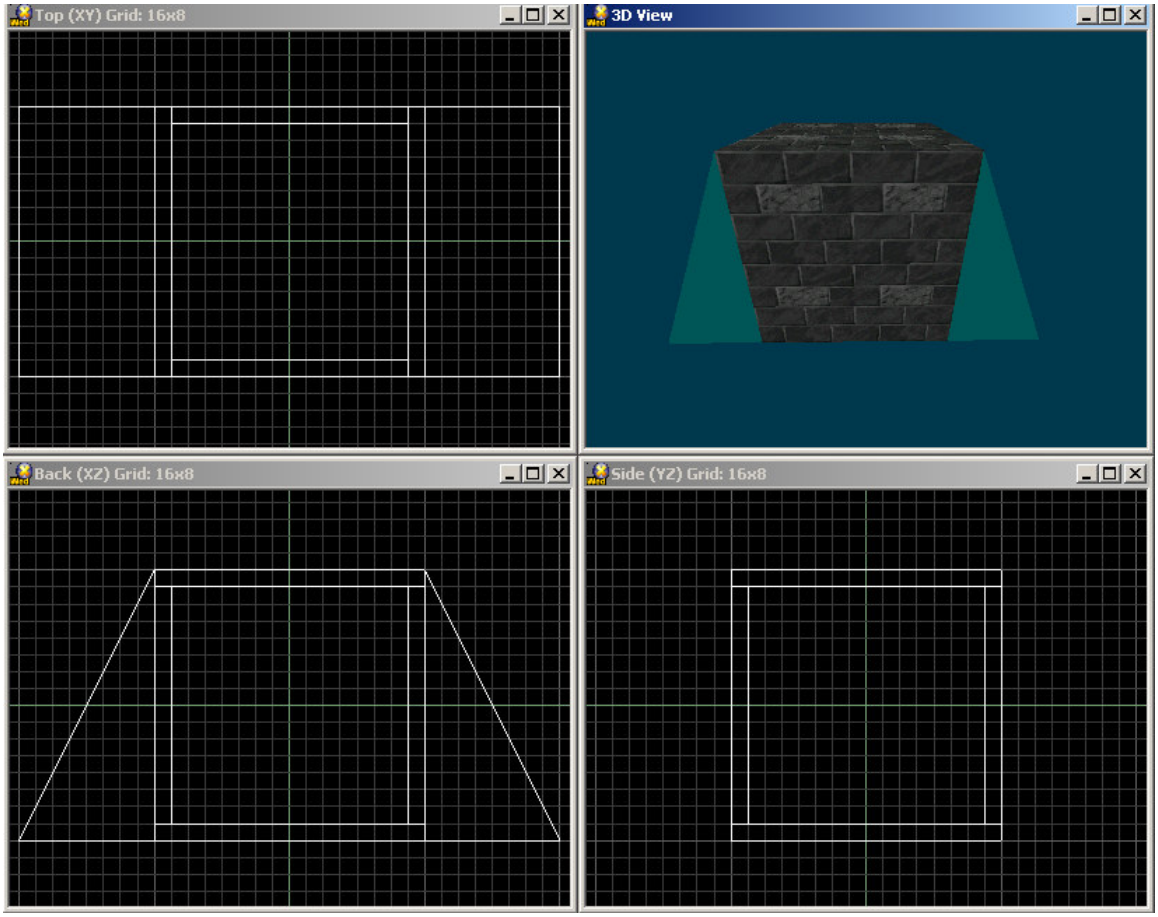
Next click on "Preferences", you will see five tabs, "Main", "Advanced", "Colors", "Key", and "Editors" we will start with "Main". "Snap" is the same "snap" as on the "Icon Bar". "Rotate Snap" is similar to "Snap" but applies to rotations. "Hollow Wall" sets the thickness of the wall when creating a hollow object. "Walk Speed" sets the speed for the camera in "Walk-Through" mode. "Grid Lo" and "Grid High" change the grid lines in the 2D views; these work in real time so try adjusting them and see the results. "Snapping" enables and disables snapping (like on the icon bar). "Grid Auto

Size" automatically changes the grid when you zoom in and out. "Invert Mouse" inverts the controls for the 3D view during the "Walk Through". "Show Entities" toggles whether or not to display the entities in the WED. "Group Sub Pieces" automatically groups blocks together that where broken up by "CSG Subtraction" (we will explain this later). "Startup Recent" automatically loads the last level when the WED is started. "Duplicated Offset" sets the amount duplicated blocks are moved from the original block's origin. "Video Out" is the video settings used in the 2D and 3D views in the WED. These should be set to "gxl2dx8a.dll", if you are having display problems with your views you can change it to "GXL_BASE" but you will have problems when it comes to lights and paths.

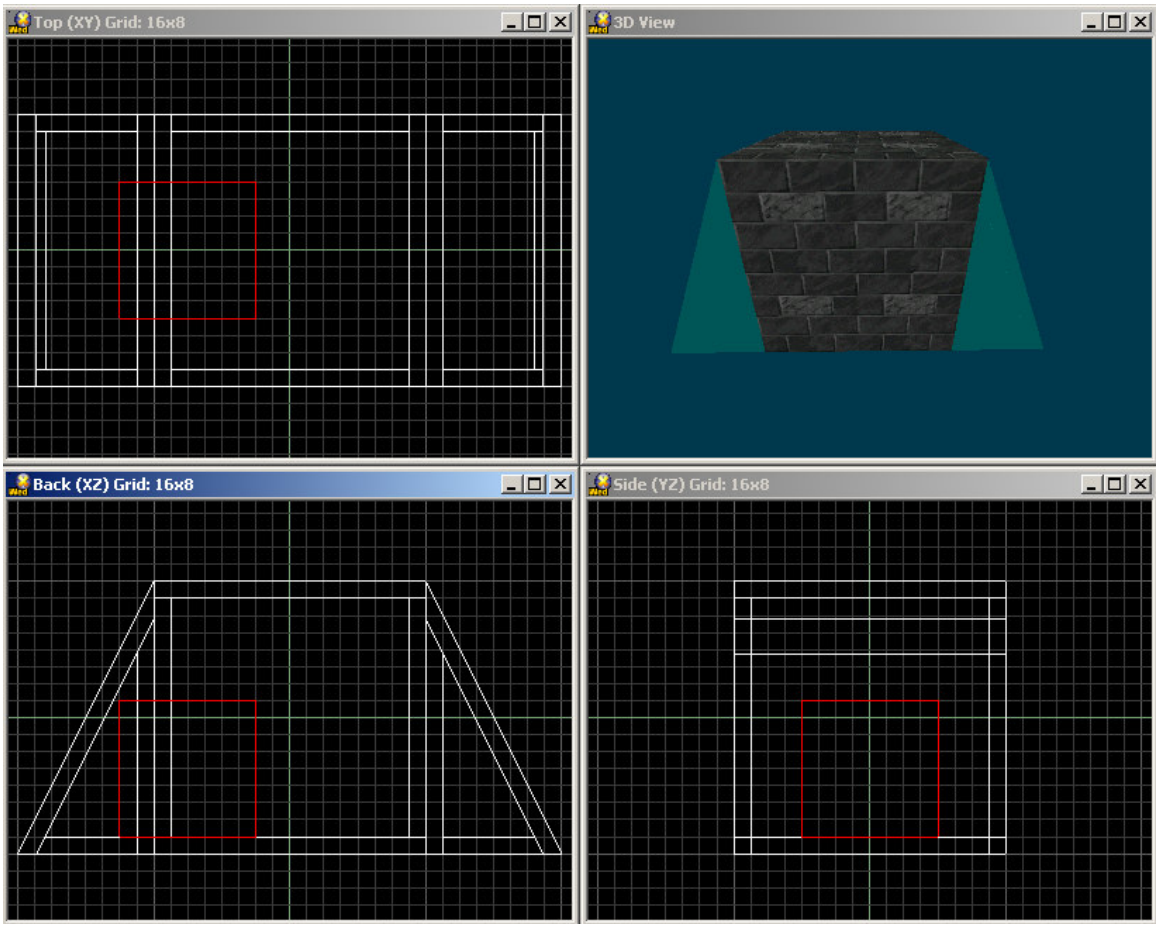
Next click on the "Advanced" tab. "Unsaved Query" if checked you will be prompted to save changes to your project before closing it. "Bound Box During Changes" when moving an entity in the WED should the entity look like the entity or the bounded box of the entity(this is useful because if the bounded box is in a wall the entity will not be able to move if collision detection is on). "Save In Win Position" saves the WED layout with the level. "Animated Textures" enables animation in textures. "Auto Default Layout" The WED goes back to its default layout after the views are scaled on if it went into full screen mode. "Texture Mipmaping" turns Mipmaping on in the 3D view. "Attach Action To View" attaches the last action performed in a view to that view, so when you go back to that view it defaults to the last action. "Display Entity Shape" shows the entity shape instead of squares. "Auto Center" when scoping down it automatically centers the group. "Sky Cube" if enabled shows the "Sky Cube" in the 3D view. "Auto Move Mode", if enabled, when adding a block automatically sets the mode to "Move". "Reload of externally modified files" checks to see if a script attached to the current project is changed and if so whether or not to load the changes. Next under the "Color" tab this controls all the user interface colors of the WED. Under the "Key" this controls the key shortcuts for the WED. Finally under the "Editors" tab this controls what program is executed when a file is double clicked on under the "Resource" tab of the Project Toolbar. This completes the "File" menu.

Edit Menu

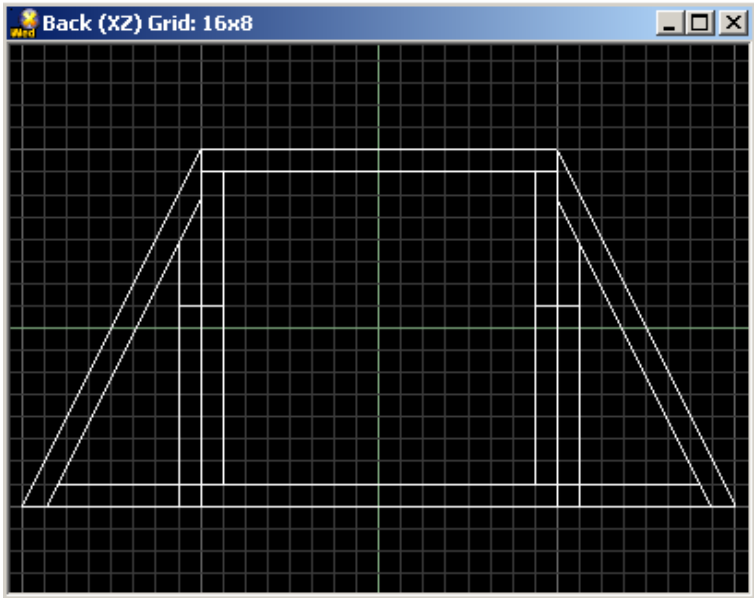
In the "Edit" menu we will start with "Realign To Grid" all the other functions before this were already covered. "Realign To Grid" aligns the current selection to the grid in the 2D views. "Hollow Block" hollows out any solid cube, this is usually used to create rooms (like the one we have in our current project). Once you hollow out cube you can not undo it so make sure to save your work before using it. Next is "CSG Subtract" this function is very important so we will spend a little time on it. "CSG Subtract" cuts holes in to a block(s) using selected block(s) as cutters. I will now demonstrate how this works. In the back 2D view "Scale" and "Move" the two triangles to look like this:



If the triangles don't line up perfectly either set the "Snap" setting lower or under the "Edit" menu click "Align To Grid". Next select one triangle and then click "Hollow Block"; do the same to the second triangle. In the back 2D view right click in the center and select "Add", "Add Cube", and then "Medium". Move the cube that you just created so that it looks like this:



Now click “CSG Subtract”. Do the same this to the other side and then delete the cube you created. The back view should now look like this:



Now we have to apply a texture to the triangles; select every thing in the level. Click on the "Texture" tab in the "Project Toolbar" and then double click on the brick texture under the "default.wad". Now compile and run the level. Look what we did; originally we had a single room now we have two doorways and two triangle shape rooms. We did this by adding two triangles, hollowed them out, and then created a doorway to connect them to the original hollow cube.

Now we will continue with the rest of the "Edit" menu. Next is "Object Mode"; under this drop-down list you can restrict which objects in the WED that can be edited (default is "All Objects"). The last function in the "Edit" menu is "Find Object" using this you can find any block or entity in the level.

"Mode" Menu

We will skip the "Mode" menu because all of the functions were already covered in the "Icon Bar".

"Object" Menu

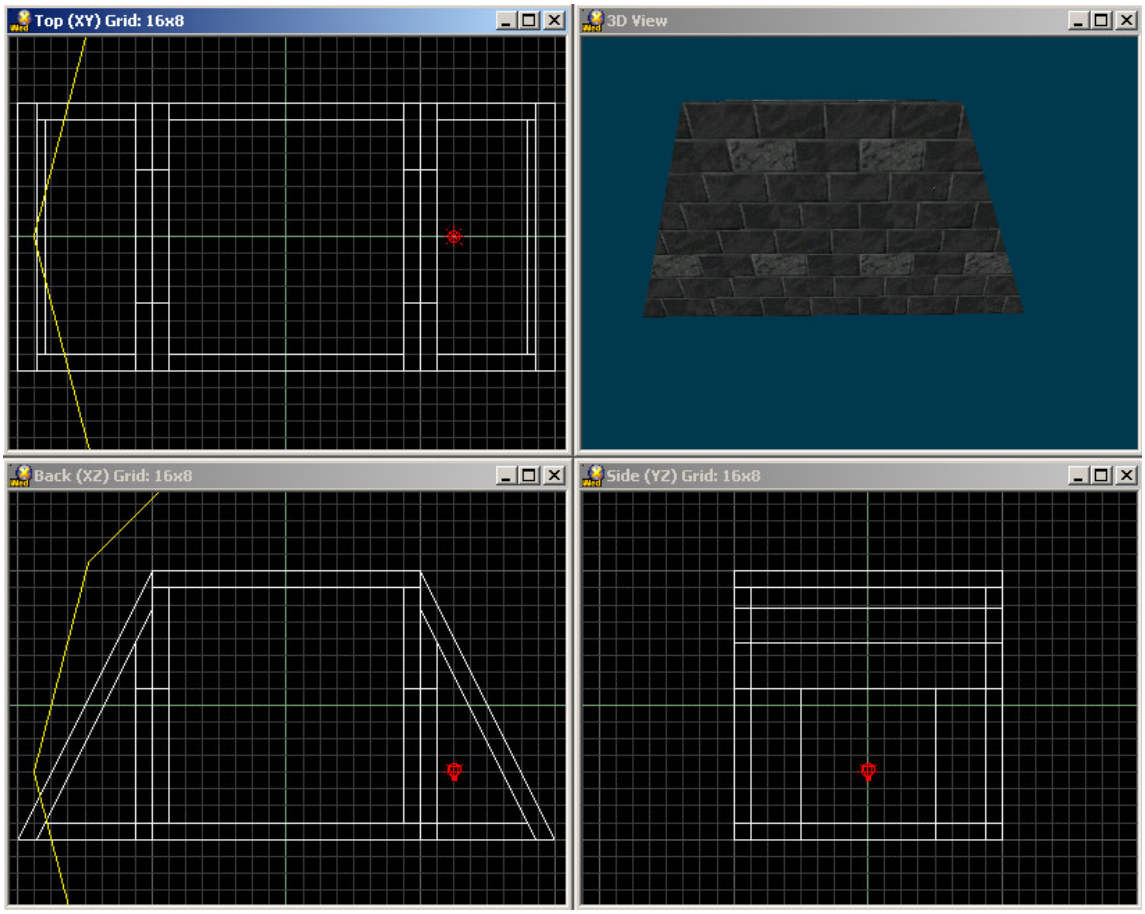
The first function under the "Object" menu is "Group". You use the "Group" functions to group and ungroup sets of blocks. This makes it easier to manipulate sets of blocks, such as a room. Let's start by selecting one triangle and then click on "Group". You will see three functions "Add To", "Finish", and "Ungroup"; click on "Add To". The triangle should now be light brown. Do the same thing to the other triangle and then click on "Finish", the triangle are now one group. If you move or resize them they are manipulated like one block. Now click on "Group" again and you will see that you can either select "Add To", in which case you can make the group bigger, or you can select "Ungroup" which ungroups the two triangles, click "Ungroup". If you select one of the triangles or the hollow block and click ungroup each side of the item that was ungrouped turns into a separate item, thereby making it very hard to move the whole item (and is not recommended).

The rest of the "Object" menu adds different items to the level. Everything that starts with "Add" can also be accessed by right clicking in any view and is listed under the "Add" menu there. "Add Cube", "Add Hollow Cube", and "Add Primitive" all add different blocks to the level. "Hollow Cube" adds a group of blocks to create a single hollow cube and the rest add a single block in a specific shape.

"Add Prefab" opens the "Add Prefab" browser. Inside the browser you will see multiple categories; in each category there is a list of level files (.wmp). These level files can be added to the current level thereby adding a group(s) of blocks that create something. For example, click on "Bridges", click on "BRIDGE02.WMP", and then click "OK". You will now see a bridge on you level,; it consists of "BRIDGE02" that is made up of three groups and these groups are made up by multiple blocks. Any level can be a prefab; for example if we wanted to use the room that we created as a prefab we open a new level click "Object", "Load Prefab", select "TheBasics.wmp" (the file that we are working on), and then click "OK". The room that we are working with will now show up in the new level as a group called "TheBasics". You can add, remove and rearrange the "Add Prefab" browser by using the Windows Explorer and opening the "GStudio6"

folder. In there you will find a folder named “prefabs” in that folder there are subfolders that have all the prefab categories and in these subfolder are the prefab files (.wmp).

“Add Light” adds a light to the level. The light has two variables color and range; these can be set by right clicking on the light and clicking “Properties”. The default range is 300 which are displayed in the 2D views as a yellow circle. Set the range to 400 and place the light as follows:



Now compile and run the level. Notice that one side is light and the other is dark, also note how shadows look. Now go back to the WED and try changing the color of the light.

“Add Sound” adds a sound file to the level. The sound file is continuously looped. The closer you are to the origin of the sound the louder it is. The volume and the range can be set by right clicking on the sound and selecting “Properties”. By default there are no sounds in the “Add Sound” menu; to add a sound you can either place the sound file in the project folder or select “Load Sound”. You will find a sound “beamer.wav”, place it on the opposite side of the light. Now compile the level and run it. Notice the closer you get the louder it is. Also note, if you have stereo speakers, that as you rotate the sound is louder in the speaker that is closer to the sound.

"Add Position" adds a map position that can be accessed in the c-script program. If there are no player entities placed in the level the first position is a camera view.

"Add Map entity" is similar to "Add Prefab" that it adds any level file from the current project folder into the level but it converts it into an entity instead of keeping it as separate blocks. This is useful for doors, elevators, etc. that are simple squares and can easily be created in the WED that have to move like entities. Since they are loaded in as entities they cannot be edited only scaled. The level files (.wmp) must be placed into the project folder for them to be loaded.

"Add Model" adds a model entity (.mdl) from the current project folder into the level. These entities are usually the player, enemies, and objects that have to move or have great detail. These models can be animated and can be created in the MED or imported from another graphics program.

"Add Terrain" adds a terrain map (.hmp) to the level. The terrain map can be created in the MED or imported from another graphics program into the level.

"Add Sprite" adds a sprite entity (.pcx) from the current project folder into the level. These entities are used for fixed 2D objects, such as flowers, pictures, and fake windows. The sprites can be created in graphic programs and imported into the level.

"Add Path" adds a path node to the level. The path can then be attached to an entity (e.g. an enemy) and in the c-script you can program the entity follow the path. To add more nodes to the path click in the "Vertex Move" icon and click on different points in the level where you want the additional nodes. To connect the last node to the first node, hold down the "Ctrl" key while dragging the last node the first.

The next three items on the menu, "Load Entity", "Load Sound", and "Load Prefab" do the same as their "Add" counterparts but these let you browse your computer for the file wanted and then automatically imports them to your project folder and adds them to your level.

The last function "Save Prefab" saves the selected blocks as a .wmp file so it can be used in other levels.

"Texture" Menu

The texture menu controls the textures for the WED. Textures are applied to blocks to give them a visible surface. For example, if you want a wood floor in the room you are creating you apply a wood floor texture to the block that is the floor to the room. In order for the level to compile every block must have a texture.

The texture menu works together with Texture tab in the Project toolbar. We will start first with "Texture Manager". Open the Texture Manager and in there you will see a number of buttons. The first on "New WAD" creates a new WAD file that holds textures in it. "Add WAD" adds an existing WAD file to the Project Toolbar. "Add Folder" adds all the textures of a given folder into a WAD. Texture can be either .bmp or .pcx. "Save WAD saves the current WAD if it has been changed. Build WAD creates a new WAD with all the textures that are used in the current level. Finally, "Remove WAD" removes the selected WAD form the WED.

Now we will go back to the first item in the menu. "Apply to Object" applies the selected texture in the Project Toolbar to the selected blocks.

"Texture Lock" is used to keep the texture map in place when it is copied and pasted within the same level.

"Texture Bookmarks" is used to store your favorite textures.

"View" Menu

"GXL Properties" controls the properties of the 2D and 3D views. In most cases you will never have to change these properties.

"Toolbar" lets you choose which toolbars should be displayed in the WED. For most of the level design you will want all the toolbars opened unless you need more room.

"Add View" adds another view in addition to the four views that are currently defaulted in the WED.

"Wire Frame" changes the rendering of the 3D view to a wire frame.

"Solid" changes the rendering of the 3D view to solid blocks.

"Textured" changes the rendering of the 3D view to full texture. For most of the level design you will want to leave it on this setting.

"Goto Center" centers the selected view to the middle of the level.

"Lock Views" if enabled keeps the three 2D views together. If you move around the level in a 2D view the other adjust as well.

"Lock 3D View" if enabled locks the 3D view to the 2D views.

"Decrease View Depth" and "Increase View Depth" changes how far you can see in the views. This helps in editing, for example if you have multiple street blocks and you want to only work on one block at a time you set the view depth just enough to see one block.

"Default Layout" sets the layout of the WED back to its default.

"Help" Menu

"Contents" opens up the user manual of the 3DGameStudio. The manual is a very useful tool to learn the program.

"Updates" opens a web browser and take you to Conitec's to check for program updates.

"Community" opens a web browser and takes you to Conitec's online forum. This is very useful if you have questions that the manual doesn't address.

"About WED" gives you the license information about the WED.

Chapter 3
Script Editor
SED

Introduction

The Script Editor, SED is where all of the programming for the game is done. C-Script is a language produced by Conitec specifically for 3DGameStudio. It is a very powerful programming language that can be used for almost all your 3D programs. If there is something that C-Script cannot do and you want to use C++ the SED has an SDK that allows you to use C++ .dll files.

Level Design

To start we need a blank page to see the results of our program. The problem is that there is no blank page in 3DGameStudio. To fix this is that we make a large hollow square in the WED. Open the WED and add a large hollow cube, place it in the center of the level and place a dark solid texture on it. Build and save the level. Next click “File”, “Map Properties”, and under “Script” click the “New Script” button, and select “Empty Script”. Next under the “Resources” tab under “script files” double click on the file you just created, this will open the SED with a blank page. This editor is the very similar to a standard editor the major difference is, is that when you run the program it opens a 3D world. Click on “Options” then “Configuration”, in the “CSC/WDL file to run” select the current file and then click “OK”. Now we will start coding.

C-Script

First we have to set up the screen for displaying the game.

```
var video_mode = 7;
```

video_mode sets the resolution of the screen to 800x600. When you type the word “video_mode” you will notice under the “Command Help” tab on the bottom of the page that it has a description of what video_mode is and all the different values it can be set to (e.g. 6 is 640x480). This is a very valuable tool for learning the different commands in C-Script.

Next we set how many colors the program displays.

```
var video_depth = 32;
```

This sets the color to 32 bit.

Next we have to tell the script which level file to load. First we set a string with the files name in it.

```
string CScript_wmb = <CScript.wmb>;
```

This line of code places CScript.wmb into string CScript _wmb (similar to “String a = “Hello”;).

Next we set up a main function that starts and runs the program.

```
function main()
{
	level_load (CScript_wmb);
}
```

The main function should always be on the bottom of your code or you should declare all the functions before the main function.

If you run the program now you will see a blank wall, this is the inside of the hollow cube. Hit “Esc” and you will exit.

Next let’s set some variables. C-Script does not have char, int, float, etc. all it has is var.

```
var a = 0;
var b = 0;
var c = 0;
```

Next we have to set up something to display the text. C-Script has a text function and in it you set the parameters for the text.

```
text box
{
	pos_x = 10;
	pos_y = 10;
	string = "a = \nb = \nc = ";
	flags = visible;
}
```

This code creates a textbox called box, it sets its x position from the top left corner to 10 pixels and the y position to 10 pixels. Then it types out the string a=, b= c, each on different line (\n), and then sets it to visible. There are many flags and attributes that can be set in the text functions but for now this is enough. Run the program and see what we created so far.

Next we need something to display the variables.
C-Script has a function called panel. A panel is used to display variables and pictures.

```
panel display_pan
{
	pos_x = 0;
	pos_y = 0;
	digits = 35, 10, 3, _a4font, 1, a;
	digits = 35, 19, 3, _a4font, 1, b;
	digits = 35, 28, 3, _a4font, 1, c;
	flags = overlay, refresh, visible;
}
```

The position of the panel is 0,0. Digits sets the x, y position of each digit, then it sets the length(3), next it sets the font, next it set the factor that the variable should be multiplied by(1), finally it sets the variable. Flags set the properties of the panel itself.

Now we are ready for some basic coding.
The game must run in a while loop so,

```
function main()
{
	level_load (CScript_wmb);
	while (1)
	{
		c = a - b;
		wait (1);
	}
}
```

Every while loop must have a wait at the end of it to let other programs execute between each run of the while loop. We have c=a-b; this is simple subtraction. Set var a =5 and var b=2, now run the program. You should see a = 5, b=2, and c=3. You can change the variables while the program is running by pressing “tab” and then “a=10;” this changes a to 10 and updates c to 8.

Recursion in C-Script

Let’s try some complex code. C-Script supports recursion so we will try the Ackermann function.

```
function ack(a,b){
	if(a==0){
		return (b+1);
	}
	if(b==0 && a!=0){
		return (ack(a-1,1));
	}
	else{
		return (ack(a-1,ack(a,b-1)));
	}
}
```

Next change the code in the while loop to: c=ack(a,b); and change var a to 1 and var b to2.(if these get set high it will crash the Acknex game engine) Now run the program. You should see the two variables and c is the answer to the function.

Now we will just make it look a little better let’s set “c” to “Ackerman”,
In the text box change string to:

```
string = "a = \nb = \nackermann = ";
```

If you run the program now you will not be able to see the value of c because it's being covered over by the work "Ackermann". So change the x position of the c variable in the panel to 80, so: digits = 80, 28, 3, _a4font, 1, c;
We finished writing our first program.

See appendix A for the complete program.

Chapter 4
Entity Movement

Introduction

In this chapter we will discuss how to move entities in 3DGameStudio. We will start with simple movements and then advance to animated movements such as walking and jumping.

Level Design

In the WED create a new project. Add a large hollow cube and expand it so it is huge. Apply any kind of texture to the room. Next place a camera ("Add Position") to the side of the room facing the center. Now we will add an entity to move. Look the movement folder and load the ship entity. Make sure that the ship is in the middle of the room and the camera is facing it. Now compile and run the level; you should see a room with a ship in the middle. This is going to be our room for the movements.

C_Script

Next add an empty script to the project and open the SED. We will start with setting up the SED for a standard program.

```
var video_mode = 7; // 800x600 pixels
var video_depth = 32; // 32 bit mode
var video_screen = 1; //full screen

string Movement_wmb = <Movement.wmb>; //string with level name to load level

function main()
{
	level_load (Movement _wmb); //load level
	wait(3); //wait three cycles for level to load
}
```

Next we will add an action to attach to the entity. Since most of the functions of the ship have to be in a while loop we will add that first.

```
action ship
{
	while(1)
	{
		wait(1); //allow other programs to run once per cycle
	}
}
```

Set the "file to run" to the current project file and run the level. You will see the same thing like you saw in the WED. If you want to the camera around you first must press "0". Next go back to the WED and right click on the ship, select behavior and select

ship. This applies the ship action in the SED code to the ship in the WED. Now back to the SED for the coding.

Every entity has x, y ,z, pan, tilt, and roll function built in. So if we say ship.x = ship .x+1 it moves the ship one space forward on it x axis. To do this in C-Script is very easy; it goes as follows:

```
my.x = my.x+1;
```

"my" is the way of saying this entity that I am programming with this action. We want to move the ship along the x axis while we are pressing "w", so we place the following in the ship's while loop:

```
if(key_w == on) //if the w key is pressed
{
	my.x = my.x+1; //move ship along the x axis
}
```

Now run the level and press "w"; you will see the ship move forward. Now do the same for backward, right, left, up, and down, pan, tilt, and roll. For pan, tilt, and roll instead of using x, y, z use pan, tilt, roll. (See Appendix B for the code.)

You might have notice that the ship can go right through the wall. The reason for this is that there is no collision detection setup in the script movement. To move an entity with collision detection we use a function call c_move. The c_move function replaces my.x = my.x+1. It works as follows: c_move(my, nullvector, vector(1,0,0), glide). "my" is the entity that is being moved. "nullvector" is saying do nothing, this parameter controls the ships x, y, and z coordinates based on the ship; meaning if the ship is facing down and you call a c_move with vector(1,0,0) the ship will move down. "vector(1,0,0)" is saying move along the x axis in relative to the world; so no matter what direction the ship is facing it will always move in the same direction. Finally, "glide" is saying what to do upon impact with an object. There are many commands that can be activated upon impact but this is just one of them. For most game we will want the ship to move based on the ships coordinates so change the c_move command to c_move(my,vector(1,0,0), nullvector,glide); do this for all the x, y, and z commands. Now when you crash into a wall you stop; the problem is that if you rotate you still can go through the wall. To fix this we use a function called c_rotate. So to convert my.tilt = my.tilt+1 to collision detection we do as follows c_rotate(my,vector(0,1,0),glide). "my" is the entity that is being moved, "vector(0,1,0)" is the angle that is being changed, and glide is what happens when a collision occurs. Replace the pan, tilt, and roll with c_rotate. You now have complete control of the ship with collision detection.

The problem with this is that what happens if you run the game on a slower or faster computer then what the game was designed for; your player will move at different speeds. To fix this we have to multiply the movements my a function called "time". Depending on your computer you have to adjust the speed of the movement, on mine I changed it to five. The c_move function now looks like this: c_move(my,vector(5*time,0,0), nullvector, glide). Change all the code using "time". (See the complete ship action code in Appendix C.)

Here is the problem we have with the ships movement. You will notice that if you make a few rotation in different directions the controls get awkward. This is because c_move adjusts the angle based on the world not the ship. To fix this we need some math to keep track on the angles. Luckily C-Script has a lot of math built in so here we go.

```
vec_set(temp.pan,vector(0,0,0));
```

This line of code is simple it sets temp to 0. This is used because each cycle of the while loop we want to reset the pan of the ship. Temp is a built in variable and does not have to be declared. Next is:

```
temp.pan += 5 * (key_j - key_l) * time;
temp.roll += 5 * (key_n - key_m) *time;
temp.tilt += 5 * (key_k - key_i) * time;
```

Over here we are setting the pan, roll, and tilt of the temp. I also shortened the code instead of writing if(key_j == on) I simply wrote key_j. The reason why this works is that key_j when pressed returns 1. So when it's pressed it is multiplied my 5 which is 5 and then added to the pan of temp. When "l" is pressed it also returns 1 but since it has a "-" before it multiplies 5 by -1 which is -5 thereby decreasing the pan of temp by 5. The same applies for roll and tilt. So far nothing too hard; next is:

```
vec_to_angle(temp.pan,nullvector);
```

This sets the temp.pan angle to "0"; this is because we will take the pan of the ship and place it in the temp. Next is:

```
ang_add(temp.pan,my.pan);
```

This function adds the current pan of the ship to the temp. Next is:

```
vec_diff(temp.pan,temp.pan,my.pan);
```

This function gets the difference of the last two angles and places it into the first vector; thereby giving the direction from the first angle to the second. So in our case it calculates the direction from the current ship angle to the desired temp angle and stores it in temp. Next is:

```
c_rotate(my,temp.pan,glide)
```

This rotates the ship with collision detection using the temp angle.

Camera

If you want to be a player in the ship we must setup the camera to view from the ship. First we need to set up two array variables that store the position and angle of the camera. On top of the page before any of the functions type:

```
var cam_pos[3];
var cam_ang[3];
```

This creates each variable array with three locations. Next we create a function called view_ship. In side this function type:

vec_set(cam_pos,vector(-100,0,25));

This copies the vector into the variable, cam_pos. This vector sets where the camera will be relative to the ship, so it will be back 100 quants and raised 25 quants.

vec_rotate(cam_pos,my.pan);

This function rotates the angle around the origin; thereby during a rotation it keeps the camera angle on the ship.

vec_add(cam_pos,my.x);

This function adds both positions and stores the result in the first position.; thereby storing the location of my.x in variable cam_pos.

vec_set(camera.x,cam_pos);

This now copies the cam_pos to the camera.x thereby moving the camera into position.

vec_diff(cam_ang,my.x,camera.x);

It now gets the difference between my.x and camera.x thereby getting the direction from camera.x to my.x and storing it in cam_ang.

vec_to_angle(camera.pan,cam_ang);

Now it rotate the camera pan to the one stored in cam_ang.

camera.tilt = my.tilt;
camera.roll = my.roll;
camera.pan = my.pan;

These last three lines keep the camera line up with the ship. If you run the program now you will see the ship in front of you just like an arcade game.

If you want to be in the ship instead of looking at it from the outside set the vector to vector(0,0,0) or nullvector. This places the camera at the center of the ship. Next in the camera's code type:

camera.genius = my;

This makes what ever is calling this function invisible. The reason for this is that since we are going to be in the ship we do not want to see the ship itself.

Now in the action of the ship call this function right before the wait(1) in the while loop. This way the camera will be updated once a cycle.

(See Appendix D for complete code)

Character Animation Movement

Now we will start movement with characters. Characters are harder to move since they need to be animated while try are moving. For example if we have a character walk across the room the must move their hands and feet. To start we must have an entity that has animation properties already set in their file. Start the MED and find the warlock.mdl file that is in the work file in GStudio6 folder. This model is included with

3DGameStudio. Click on the animate button that is on the bottom of the screen. Now click on the right arrow, you will cycle through all the Warlock's animations; stand, walk, run, duck, crawl, jump, swim, attack, and death. These animations where made in the MED or some other modeling program and saved in the file. We are able to access these animations in the SED to be used in our game.

In the WED delete the camera or you can start a new project. Add the Warlock into the level and place him on the floor opposite the camera. In the SED delete everything from the while loop in the ship action. Change the name of the action from ship to warlock and the view_ship function to view_warlock. Run the script and exit. Go to the WED and apply the warlock action to the warlock model and compile the level. Back in the SED we will now start coding the warlock's movements.
We need two variables to control the animations.

```
var anim_cycle;
var anim_speed=2;
```

"anim_cycle" keeps the animation from going over or under its set cycle and anim_speed controls the speed of the animation.

Inside the Warlock's while loop we set up the stand animation. This animation is run when the warlock is standing still.

```
if(key_any == off) //if no keys are pressed
{
	ent_animate(my,"stand",anim_cycle,anm_cycle);
	anim_cycle += anim_speed * time;
	anim_cycle %= 100;
}
```

This code says if no keys are presses execute the stand animation cycle. "ent_animate" animates the entity my executing the entities internal animations. The first parameter (my) is the entity that is going to be animated, the second is a string (stand) that has the model's name of the animation to be executed, the third (anim_cycle) is the percentage of the animation the should be executed, and the final parameter (anm_cycle) tells the engine that the cycle is cyclical (i.e. walking, standing). The next line "anim_cycle += anim_speed * time" this sets how fast the percentage of the animation should be ran through. "anim_cycle %= 100;" makes sure that the animation cycle doesn't go over 100%.

If you execute the program now you will see the Warlock breathing in and out.

Now we will work on the walk animation.

```
if(key_w == on)
{
	ent_animate(my,"walk",anim_cycle,anm_cycle);
	anim_cycle += anim_speed * time;
	anim_cycle %= 100;
	c_move(my,vector(4*time,0,0), nullvector,glide);
```

```
}
```

If the “w” key is pressed execute the walk animation with c_move. This movement code is the same as the ship’s movement code except that it has the animation code. The rest of the controls are the same as the ship except since a person doesn’t rotate like a ship you can leave the unnecessary ones out. You can also add the camera function to the Warlock the same way we did to the ship. To make the warlock run increase the c_move speed and execute the “run” animation. Just a note if the Warlock’s walk animation doesn’t look smooth this is because he has a limp.

Chapter 5
Special Effects and Basic AI

Introduction

So far we created a player and can move it. Now we want special effects, such as bullets, missiles, and explosions.

Level Design

First let's create an enemy to kill. In the WED add the Witch model from the work folder. Set it off to the right side of the room facing the center. Now back in the SED add a new action called witch and add a while loop with the condition while(my != null). This will execute the while loop as long as the entity is still there. Save the script file and go back to the WED. Apply the Witch action to the Witch and compile the level.

C-Script

Now we define a skill. Each entity has 100 skills; these skills are variables that are exclusive to the entity. The first skill we are defining is the health points.

```
define healthpoints = skill1;
```

Now we can refer to skill1 as healthpoints. Now we will give the player 100 healthpoints and the Witch 30 healthpoints. In the beginning of the player's action outside the while loop add:

```
my.healthpoints = 100;
```

In the Witch's action add the same thing but only give her 30 healthpoints. Since these are skills they are considered different variables and they won't interfere with each other even though they have the same name. Now change the condition in the while loops to while(my.healthpoints>0) this says as long as the player is alive execute the while loop. Once the player dies it will exit the while loop and we will put a death sequence there.

We will now add another function called shoot this will have a while loop saying if the player is alive and you press the space button, shoot.

```
function shoot()
{
	while(my.healthpoints>0)
	{
		if(key_space==on)
		{
			ent_create("blue.bmp",player.x,shoot_action);
			sleep(.3); //pause between shots
		}
		wait(1);
	}
```

```
}
```

The “ent_create("blue.bmp",player.x,shoot_action)” function says create a sprite from picture file blue.bmp in the position of the player’s x and give this sprite entity the commands in function shoot_action.

Now we will code shoot_action this is commands for the bullet.

```
function shoot_action()
{
  my.enable_impact = on;
  my.enable_entity = on;
  my.enable_block = on;
  my.enable_stuck = on;
  my.event = remove_func;
  my.pan = you.pan;
  my.tilt = 0;
  my.roll = 0;
  my.passable = off;
  my.facing = on;
  my.overlay = on;

  while(1)
  {

c_move(my,vector(10*time,0,0),nullvector,activate_trigger+ignore_passents+ignore_pas
sable+ignore_me+ignore_you);
    wait(1);
  }
}
```

my.enable_impact = on, my.enable_entity = on, and my.enable_block = on all tells the engine that if this bullet hits an entity, is hit by an entity, or hits a block it should trigger an event. “my.event = remove_func” this is the function that gets executed when the event is triggered. The pan, tilt, and roll commands give the direct of the bullet; in this case it should follow the player direction. “passable = off” makes it that the bullet can’t pass through anything. “my.facing = on” makes it that the sprite always faces the screen thereby making it look 3D. “my.overlay = on” makes the black parts of the sprite invisible. The c_move function gives the direction and the speed of the bullet. The ignore statements in the c_move function tells the engine what things to ignore for collision detection.

Now let’s look at the remove_func.

```
function remove_func()
{
  wait(1); // make sure it exist at least one frame
  ent_remove(me);
```

```
}
```

This code is simple enough. It says remove what ever is calling it. In this case it's the bullet; so when the bullet hits something it is going to be removed.

OK so now we have the bullet; but how does the Witch die? First we have to create events it the Witch's action. Before the while loop type:

```
my.enable_impact = on;
my.enable_entity = on;
my.event = im_hit;
```

This code is the same as the bullet function so I will not explain them here. Now we have to program the im_hit function.

```
function im_hit()
{
	if(my.healthpoints>0)
	{
		my.healthpoints -=10;
	}
}
```

This function says that as long as the Witch is alive deduct 10 health points. Now once the Witch loses all her healthpoints she dies when this happens she exits her while(my.healthpoint>0) loop now we have to enter code for her death sequence.

```
while(temp < 100 && my.healthpoints<=0)
{
	my.passable=on;
	ent_animate(my,"death",temp,null);
	temp+=3*time;
	wait(1);
}
```

This code says that make the Witch passable and as long as temp is less then 0 play the death animation of the Witch. "temp" is then incremented by three it is then used to increase the percentage of the animation that is played. When the percentage player reaches 100% the animation ends.

Now run your level. Turn the Warlock toward the Witch and shoot her three times. You will now see the death animation.

If your program is not running correctly make sure that you either declared all the function on top of the code or you wrote any function that is called in another function before that function.

Basic AI

This game would be pretty boring if the Witch didn't shoot back so let's give the Witch some basic AI code. Let's say as follows, when the Warlock shoots the Witch the Witch turns toward the Warlock and shoots back.

First we have to add code that allows the Warlock to get hit my bullets, so in the Warlock's action before the while loop add:

```
my.enable_impact = on;
my.enable_entity = on;
my.event = im_hit;
```

This code and the next is the same as the Witch's. Next we have to add the death animation to the Warlock's action. After the main while loop add:

```
temp=0;

while(temp < 75 && my.healthpoints<=0)
{
	ent_animate(my,"death",temp,0);
	temp+=2*time;
	wait(1);
}
```

Now we have to program the Witch to turn to the player and shoot. First we need the set a variable to check if the Witch was hit by a bullet. So on top of the page add:

```
var im_shot=0;
```

In the Witch's action add:

```
if(im_shot==1 && player.healthpoints > 0)
{
	vec_set(temp,player.x);
	vec_sub(temp,my.x);
	vec_to_angle(my.pan,temp);
	ent_create("red.bmp",my.x,shoot_action);
	sleep(1);
}
```

If I am shot and the player is alive execute the following code.

"vec_set(temp,player.x)" copies the player.x to temp. "vec_sub(temp,my.x)" subtracts witch's x from the player's x and stores it in temp.
"vec_to_angle(my.pan,temp)" copies the pan and tilt from the temp vector and places them into the my.pan thereby turning the Witch toward the Warlock.
"ent_create("red.bmp",my.x,shoot_action)" this creates a sprite from the picture file

red.bmp in the position of the Witch's x and gives this sprite entity the commands in function shoot_action. "sleep(1)" keeps the Witch shooting at one bullet per second.

Last we have to add code to activate the im_shot flag. In the im_hit function after the deduction of healthpoints add:

```
im_shot = 1;
```

Special Effects

Explosions

Now let's add an explosion when the bullet hits. To start we will set a pointer at the top of the page. Pointers are used to refer to an entity.

```
entity* ent_pointer;
```

This creates a pointer called "ent_pointer". We also need a .bmp file for the particle map for the explosions.

```
bmap explosion_particle_map = <fireball_sprite.pcx>;
```

Next we will create a function called "small_explosion" with a parameter called "entity_handle". This will be used to pass the handle to the entity that is calling the function into the function. The handle is the unique identification number that each entity has.

```
function small_explosion(entity_handle)
{
	var pos_vec[3];
	var count = 10;
	ent_pointer = ptr_for_handle(entity_handle);
	if (ent_pointer != null)
	{
		vec_set(pos_vec, ent_pointer.x);
		pos_vec.x += (random(6) - 3);
		pos_vec.y += (random(6) - 3);
		pos_vec.z += (random(6) - 3);
	}
	while (count > 0)
	{
		effect(small_explosion_particle, 2, pos_vec.x, nullvector);
		count -= 1;
	}
}
```

"var pos_vec[3]" is a local variable array of three used to store the position of the entity that called this function. "var count = 10" this is going to be used as a counter. "ent_pointer = ptr_for_handle(entity_handle)" converts the entity handle to an entity and

stores it in ent_pointer. “vec_set(pos_vec, ent_pointer.x)” copies the position of the entity to variable pos_vec. It then randomly generates the x, y, and z values around the original position. It then calls the effects function ten times in the while loop. The effects function has four parameters. The first is the function that controls the effect in our case it’s “small_explosion_particle”; the second is an integer that controls how many particles should be created in our case “2”; the third is the position it should be created in our case it’s “pos_vec.x” and the last is the velocity of the particles here its “0” (we will change this in “small_explosion_particle”).

Now we have to write the function that controls the particles, “small_explosion_particle”.

```
function small_explosion_particle
{
	var velocity_vec[3];
	velocity_vec[0] = random(4) - 2;
	velocity_vec[1] = random(4) - 2;
	velocity_vec[2] = random(4) - 2;
	vec_set(my.vel_x, velocity_vec.x);
	my.move = on;
	my.bmap = explosion_particle_map;
	my.alpha = 80;
	my.lifespan = 100;
	my.size = 10;
	my.flare = 1;
	my.function = explosion_fade;
}
```

“var velocity_vec[3]” is a local array variable used to store the velocity of the particles. The next three lines generate random numbers for the x, y, and z for the variable “velocity_vec”. “vec_set(my.vel_x, velocity_vec.x)” copies the velocity of the variable to the velocity of the particles. “my.move = on” sets it that the particles move. “my.bmap = explosion_particle_map” is the picture file used for the particles. “my.alpha = 80” is used to set the transparency of the particles. “my.lifespan = 100” is the expectancy of the particles in “ticks”. “my.size = 10” sets the size of the particles in quants. “my.flare = 1” sets the flare effect to the particles. “my.function = explosion_fade” is a function that controls this function.

The last function “explosion_fade” controls how the particles fade.

```
function explosion_fade()
{
	my.alpha -= 20 * time;
	if(my.alpha < 0) { my.lifespan = 0; }
}
```

This deducts the alpha effect until 0. Once it reaches 0 the particle gets removed. Finally you have to call the “small_explosion” function right before the bullet gets

removed. In “func_remove” right before “ent_remove(me)” add “small_explosion(handle(my))” this calls the “small_explosion” function and passes the bullets handle to it.

Sound Effects

Now we have cool explosions but how do we add sound to the game? We want explosion sounds, bullet sounds, background music etc. First we will add the background music. Place the following line in the main function right after the wait(3);

```
media_loop("hauntedmansion.mid",null,50);
```

This plays the "hauntedmansion.mid” midi sound file the entire game at 50% volume. Next we will add four sound files to the level. On top of the code add:

```
sound wham_wav = <wham.wav>;
sound beamer_wav = <beamer.wav>;
sound scream_wav = <scream.wav>;
sound witch_wav = <witch.wav>;
```

This imports the sound files and gives them names. Now we have to place these sounds where we want them. “beamer_wav” will we used when a bullet is fired, so in the “shoot_action” before the while loop add:

```
ent_playsound(my, beamer_wav, 100);
```

This plays the sound beamer at 100% volume when each shot is fired. Next in “remove_func” right before the sleep command add:

```
ent_playsound(my, wham_wav, 1000);
```

This plays the wham sound using a special function to make it sound louder then 100%. Next in the Witch’s action right before the death while loop add:

```
ent_playsound(my, scream_wav, 1000);
```

Finally in the Warlock’s while loop right before its death while loop add:

```
ent_playsound(my, scream_wav, 1000);
```

OK now all the sounds are set up we are ready to convert this to a real game. (See the next chapter for the final code.)

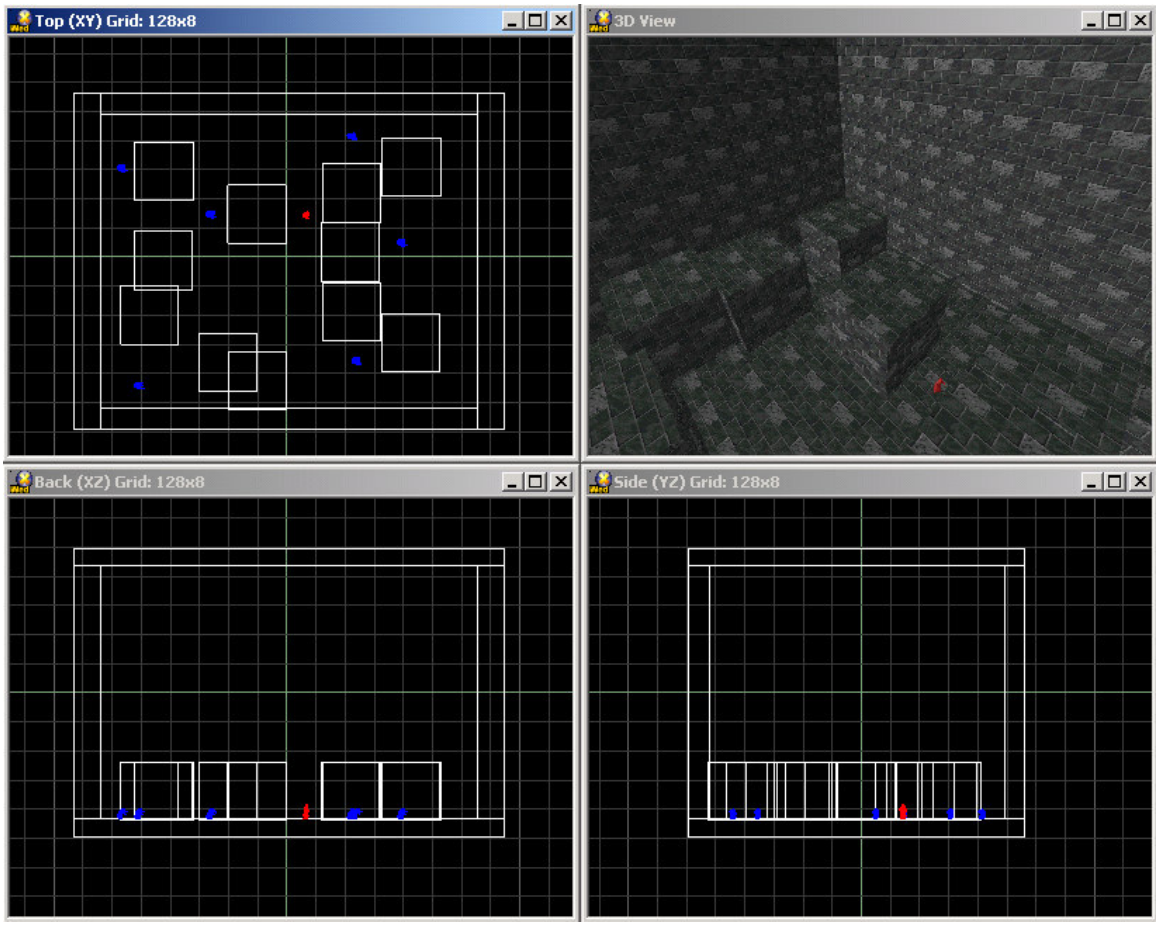
Chapter 6
Developing a First Person Shooter Game

Introduction

We will now take the code from the previous chapter and create a first person shooting game.

Level Design

First go into the WED and create a huge hollow cube; this will be the room for the level. Next place solid blocks all over thereby making smaller rooms and hallways. Now place about ten witches all over the level and place the Warlock in the center. It should look some thing like this:



C-Script

Next we have to change some of the code to accommodate the game. I included the "view_warlock" code in Appendix E place this function before the wait at the end of the first while loop. Next delete the second while loop; since we are first player we don't see the death. Right after the while loop write:

```
my.passable=on;
```

This way any bullets will go through the Warlock after he dies. Next we will make the game a little harder. The Warlock can only shoot if he is not moving. To do this, remove the call to the shoot function and place:

```
if(key_space==on)
{
	ent_create("blue.bmp",player.x,shoot_action);
	sleep(.3);
}
```

Inside the Warlock's while loop. Next in the Witch's action we have to change the if statement that is used for the attack. As of now if I attack one Witch they all start shooting even if they don't see the Warlock. To fix this we add to the if statement "&& trace(my.x,player.x)==0". The "trace" function says if it can draw a line from one point to another without hitting anything it will return 0. So if it can draw a line from the Witch's x to the Warlock's x then it can see it, then shoot. Now if you want in the beginning of the code you can change "if_shot" to 1 and the shooting will start when the first Witch sees the Warlock.

Now we will create a panel that displays the Warlock's remaining life:

```
panel health_panel // displays Warlocks life
{
	pos_x = 0;
	pos_y = 470;
	digits = 30, 30, 4, _a4font, 1, Player.healthpoints;
	layer = 1;
	flags = refresh, visible,overlay;
}
```

We already discussed panels but I will explain the features that where not yet discussed. The digit that is being displayed is the Warlock's healthpoints. "Layer" just sets the layer of the panel since it's the only panel it doesn't make a difference. "Flags" sets different functions to the panel. "Refresh" updates the panel every cycle. "Visible" makes it visible. "Overlay" makes any block see through.

Last thing we want to know when we won the game. That happens when all the Witches die. To do this we will set a counter every time a witch dies it gets decremented. When all the witches are dead the counter equals 0 and the screen displays "YOU WON".

I have six witches so my code has on top:

```
var witch_counter =6;
```

Next I created a panel to display that I won. This panel starts as not being visible.

```
panel won_panel
{
```

```
	bmap = won_bmp;
	pos_x = 400;
	pos_y = 400;
	layer = 1;
	flags = refresh, overlay;
}
```

It displays the “won_bmp” so on top of the page I have:

```
bmap won_bmp = <won.bmp>;
```

Next I created a function to check if I won:

```
function count_witches()
{
	while(1)
	{
		if(witch_counter==0)
		{
			won_panel.visible=on;
		}
		wait(1);
	}
}
```

Next we call this function after the wait(3) in the main function. (See Appendix E for the complete code)

Now you have a complete first person shooter game!!!

Chapter 7
Developing a 3D Flying Game

Introduction

Now we will work on creating a 3D flying game. This game will of a spaceship inside caverns of an alien world. The goal will be to destroy all the alien ships. Even though first person shooter games and 3D flying games are very different we can use a lot of the code from the previous game for this game.

Level Design

Start in the WED and create a full level with multiple rooms and hallways. Next place enemy ships and the ship in the starting points. Set up a path with multiple nodes for the enemy ships to use as a patrol. This path will only be used for a patrol not for path finding.

C-Script

Player's Action

We will start by programming the player's ship. The player ship will slowly accelerate when "a" is pressed and decelerate when released. The same applies for reverse and all of the rotations. To start we will set a few local variables that control the action.

```
var ACCELERATION_SPEED = .4;          // Speed factor that ship accelerates
var DECELERATION_SPEED = .4;          // Speed factor that ship decelerates
var PAN_ACCELERATION_SPEED = .3; // Speed factor that ship accelerates pans/tilts/roll
var PAN_DECELERATION_SPEED = .2; // Speed factor that ship decelerates pans/tilts/roll
var TOP_SPEED = 5;                    // Top speed of ship
var TOP_ROTATION_SPEED = 1.5;         // Limits pan/tilt/and roll speeds
```

Since the ship slowly decelerates by multiplying it will never reach 0 so the ship will constantly drift. To fix this we will set a local variable that controls when the ship reaches a certain speed stop.

```
var SHIP_CALM = .05;
var SHIP_CALM_PAN = .05;
```

Next we add a local variable that is used as a flag to keep missiles from firing more then one per key press.

```
var fire_key_clear = 1;
```

Next we will set up the events; this will control what is called an event.

```
my.enable_impact = on;
 my.enable_entity = on;
```

```
my.enable_block = on;
```

When the player gets hit the following line launches the function im_hit_player. This function checks what hit the player and if it is a bullet it deducts points.

```
my.event = im_hit_player;
```

The next line of code is used to identify the player ship during an event.

```
my._TYPE = PLAYER_TYPE;
```

The next line sets the player attributes.

```
player = me;
player.healthpoints = 100;
```

This says this entity is the player and it has 100 healthpoints. The next three line are used for the collision detection.

```
my.narrow = on; //used for collision detection
my.fat = on;
c_setminmax(my);
```

The next line "space_fire();" is a function that us used for bullet fire. This function is similar to the function in the previous program.

Next we have the main while loop for the player. The condition in the while loop is "player.healthpoints > 0"; basically if the player is alive run the loop.

Now inside the loop we will start with the controls.

```
if (key_a)    { my._FORCE_X += time * ACCELERATION_SPEED; }
if (key_z)    { my._FORCE_X -= time * ACCELERATION_SPEED; }
if (key_end)  { my._FORCE_Y += time * ACCELERATION_SPEED; }
if (key_pgdn) { my._FORCE_Y -= time * ACCELERATION_SPEED; }
```

This code says that while one of the buttons are pressed add the current speed stored in a entity variable to the "ACCELERATION_SPEED"; so as long as the button is pressed the ship will accelerate.

The next lines of code deals with the deceleration when the key is released.

```
if ((key_a == off) && (key_z == off) && (abs(my._FORCE_X) > SHIP_CALM))
{
	my._FORCE_X -= (sign(my._FORCE_X) * time * DECELERATION_SPEED);

	if (abs(my._FORCE_X) < SHIP_CALM)
	{
		my._FORCE_X = 0;
```

```
        }
}
if ((key_end == off) && (key_pgdn == off) && (abs(my._FORCE_Y) > SHIP_CALM))
{
        my._FORCE_Y -= (sign(my._FORCE_Y) * time * DECELERATION_SPEED);

        if (abs(my._FORCE_Y) < SHIP_CALM)
        {
                my._FORCE_Y = 0;
        }
}
```

The code says that if the keys are released and the movement is greater then the lowest speed allowed then decreases the speed.

The next lines of code keep the ship from going over the top speed.

```
my._FORCE_X = clamp(my._FORCE_X, -1 * TOP_SPEED, TOP_SPEED);
my._FORCE_Y = clamp(my._FORCE_Y, -1 * TOP_SPEED, TOP_SPEED);
my._FORCE_Z = clamp(my._FORCE_Z, -1 * TOP_SPEED, TOP_SPEED);
```

The “clamp” function works by keeping the first parameter (which is the speed) between the second two parameters.

The rotation code is almost the same as the forward backward movement so we won’t go over it. (See Appendix for code)

The next line of code is the actual command for the ship to move.

```
c_move(my, vector(my._FORCE_X, my._FORCE_Y, my._FORCE_Z), nullvector, glide+ignore_sprites);
```

The “c_move” command moves the ship based on entity variables. When it hits something it glides and ignores sprites. The reason it has to ignore sprites is that it keeps the bullets of the ship from hitting itself.

The major difference between c_move and c_rotate is that in c_move you can move relative to the entity c_rotate doesn’t have that. In order to rotate relative to the ship we have to add the following code.

```
vec_set(temp.x,my._FORCE_PAN);
vec_to_angle(temp.pan,nullvector);
ang_add(temp.pan,my.pan);
vec_diff(temp.pan,temp.pan,my.pan);
```

The code takes my._FORCE_PAN and converts it relative to the ship and passes the result in temp.pan.

```
c_rotate(my,temp.pan,ignore_passents);
```

Now we take temp.pan and rotate the ship. Next we will code the missile fire.

```
if (fire_key_clear == on)
{
	if(key_ctrl == on)
	{
		ent_create (rocket_mdl, player.x, rocket_action);
		snd_play (rocket_wav, 50, 0);
		fire_key_clear = 0;
	}
}

if (key_ctrl == off)
{
	fire_key_clear = 1;
}
```

This fires a rocket and plays a rocket sound. The “if” statements keep more then one rocket from firing per key press.

The next statement “view_ship();” controls the camera of the ship. Finally wait(1); is the wait required at the end of every loop. This completes the while of the player while it’s alive. The next code deals with the player’s death.

```
cd_pause();
```

Turns off the back ground CD music; the music is started in the main function at the beginning of the game.

Next we have “if(my.healthpoints<=0)” or if player is dead inside this if statement we have the death roll.

```
while(my.skill20<500)
{
c_rotate(my,vector(1,1,1),IGNORE_YOU & IGNORE_PASSABLE + IGNORE_PUSH
+ ACTIVATE_TRIGGER + GLIDE);
my.skill20 = my.skill20+1;
view_ship();
if(player.healthpoints<0)
{
	player.healthpoints=0;
}
wait(1);
}
media_play("explo.wav",null,1000);
```

The while loop uses one of the skills as a counter for the death roll; the death roll works by using “c_rotate” and increasing the pan, tilt, and roll by one each cycle. The nested if statement keeps the healthpoints from going to go below “0” if it is hit after death. At the end of the cycle an explosion sound if played.

Enemy's Action

Now we will code the enemy's action, we will call it patrol_path. We will be adding a lot of AI in this chapter but the path finding will save for chapter 8.

We will start with:

```
my._TYPE = ENEMY_TYPE;
```

This is the same as the player's. It sets the type of this entity as an "ENEMY_TYPE"; this is used to identify the type of entity for events such as collisions.

The next three lines of code are to define what sets off the event function.

```
my.enable_impact = on;
my.enable_entity = on;
my.enable_scan = on;
```

The event function is:

```
my.event = enemy_event;
```

The "enemy_event" function checks to see if the event was triggered by a scan or some other function like an impact. If it was scanned the function knows that a homing missile was fired by the player and is close enough for it to home in on. It then turns the rocket to the enemy; this controls the missile. If the event wasn't cause by a scan it checks to see if the bullet or ship collision was caused by another enemy ship or the player ship. If it was the player ship, deduct healthpoints else if it was an enemy bullet do nothing, else if it was an enemy ship move away. The reason to move is that in path finding it lets one ship pass another.

The next line sets the life of the enemy to 30.

```
my.healthpoints = 30;
```

Next we will set some local variables for the enemy.

```
var RELOAD_TIME = 20;
var sleep_counter;
```

This is used to set the time between shots. The "RELOAD_TIME" is the time it takes to reload and "sleep_counter" is used in the counter to count the time.

Next we run the "radar()" function. This function displays the current position of the enemy on the player's screen.

Next we will use the path that was created in the WED as a patrol path. It will not be used for path finding. First we have to set three local variables to store the position and information about the path.

```
var node_pos[3];
```

```
var node;
var dist;
```

The first line of code attaches the enemy entity to the path.

```
node = path_scan(me, my.x, my.pan, vector(360,180,1000));
```

The function "path_scan" scans the area around the "my.x" around "my.pan" using a vector as a guide and uses "me" as the entity that it attaches.. In our case it will look in all directions up to 1000 quants to find the path and returns one if a path is found.

Next we have to find the first node.

```
path_getnode(my,node,node_pos.x,null);
```

"path_getnode" finds the node number and places the position in "node_pos" the null is used to manipulate skills (which we are not implementing). Next we have to check if we reached the next node.

```
dist = vec_dist(node_pos.x,my.x);
```

This checks the distance between the next node's position and the enemy's position and returns the distance to "dist". The enemy almost never reaches the node exactly so we have the following code when the player is near the destination node.

```
if (dist < 25)
{
	node = path_nextnode(my,node,1);
	path_getnode(my,node,node_pos.x,NULL);
}
```

This says if the ship is within 25 quants set the "node" variable to the next node using the first edge and then run "path_getnode" again.

Now we will program what happens when the player comes into contact with the enemy.

```
trace_mode = IGNORE_ME + IGNORE_PASSABLE + ACTIVATE_TRIGGER + use_box;
trace(my.x,player.x);
```

"trace_mode" sets the parameters for the trace; what things should be ignored for the trace. "trace" traces a path between two points (in our case it's between the player and enemy). If it hits something it return >0 else it returns 0. It also sets the "you" to the entity that was scanned.

Now we have an if statement to see if the player was scanned and if it was to rotate to the player and attack.

```
if (player.healthpoints > 0 && (you == player))
{
	draw_text("JAMMED",1400/2,1068/2,vector(255,100,100));
	vec_set(temp, player.x);
	vec_sub(temp, my.x);
	vec_to_angle(my.skill2, temp); //store angle in skill 2, 3

	while(abs(ang(my.skill2)-ang(my.pan))>1 || abs(ang(my.skill3)-ang(my.tilt))>1)
	{
		draw_text("JAMMED",1450/2,1068/2,vector(255,100,100));
		vec_set(temp, player.x);
		vec_sub(temp, my.x);
		vec_to_angle(my.skill2, temp);
		my.pan -= ang(my.pan-my.skill2)*0.5*time;
		my.tilt -= ang(my.tilt-my.skill3)*0.5*time;
		wait(1);
	}
	ent_create(bullet_red,my.x,shoot_action);
	sleep_counter = 0;
	while((sleep_counter < RELOAD_TIME) && (my.healthpoints > 0))
	{
		sleep_counter += time;
		wait(1);
	}
}
```

This code says if the player is alive and the “you” entity is the player attack. During the attack the player will not see the enemy on the radar and the radar will display “JAMMED”. Next it will rotate towards the player and when it is facing it will fire a bullet. It then goes through a while loop as a counter to pause in between shots.

If the player is not spotted continue patrolling.

```
else
{
	vec_set(temp, node_pos.x);
	vec_sub(temp, my.x);
	vec_to_angle(my.skill10, temp);
	my.pan = my.skill10.pan;
	my.tilt = my.skill11.tilt;
	temp.x = 5 * time;
	temp.y = 0;
	temp.z = 0;
	c_move (my, temp, nullvector, IGNORE_YOU + IGNORE_PASSABLE + IGNORE_PUSH + ACTIVATE_TRIGGER + GLIDE);
}
```

Next we need death code for the enemy.

```
if(my.healthpoints <= 0)
{
	media_play("explo.wav",null,1000);
	explosion(handle(my));
	small_explosion(handle(my));
	my.invisible = 1;
	my.passable = 1;
	sleep(2);
	ent_remove(me);
}
```

If enemy is dead play an explosion sound, launch the explosion effect, and the small_explsosion effect. Next we can't remove the entity yet because the explosion sound and the explosions are not yet finished so set the ship passable, invisible, and wait two seconds, then remove it.

This chapter explains the code for the enemy and the player. For the code of the supporting functions see the Appendix

Chapter 8
Path Finding

Introduction

We will now discuss how to implement path finding into 3DGameStudio using c-script. For almost all path finding algorithm we need some kind of grid or nodes with fixed positions to calculate the route.

There are numerous ways to create a grid in 3DGameStudio. One way is to create a terrain and use the Vertices that makeup the terrain as nodes. This would be great if the game was on flat ground but once you are in a 3D world that you can move on the X, Y, and Z axis now you have to calculate the height of distances; because of the amount of nodes it can use a lot of computing power.

The second option is to use entity nodes, which are regular entities (like a player) but have a set place, do not move, and are invisible. This is a great option because for most games the problem is getting the enemy into the same room as the player. Once it is in the same room there is usually another AI code for the attack and path finding is not needed. The great thing about the entity nodes is that as long as each node is with in the line of site of the next node you have a path; this keeps the total count of nodes low thereby using a low amount of resources. The major problem with this method is that the level designer has to manually place each node making sure that they all line up. Once all the entity nodes are placed in the WED we implement a path finding algorithm so the enemy can find the player.

A* Algorithm

A* is a classic path finding algorithm used in AI, it is used to find the optimal path between two points using a minimal amount of computing power. The function is:

$f(n) = g(n) + h(n)$

where:

f(n) is the function of the distance of every node in the path

g(n) is the cost of the path between the initial node and the current node.

h(n) is a heuristic expressing the cheapest cost path from the current node to the destination node

We look for the lowest value of *f(n)* and follow that route. Since *h(n)* is estimated it is not always the shortest route.

The way A* Algorithm works is that each node has two values, *g* and *h*, we add these values and get *f*. We calculate *g* by adding the cost of the movement from the origin to the current node. For example, the cost to move to a forward node is 5 and then cost to move to a diagonal node is 8; if we move five forward the *g* value will be 25. We calculate *h* by calculating how far the current node is from the destination. For example, if from the current node the shortest path (this includes going through obstacles) to the destination is ten nodes, the *h* value is fifty.

We start by adding the origin to the open list, the open list is nodes that must be considered as a possible path. We then look at all adjacent nodes that can be used as a path, (walls for example will not be considered) calculate the *g* and *h* values, add them to

the open list, and mark each of these nodes as having the origin as a parent. We then remove the origin from the open list. We now look at all the adjacent nodes and find the one with the lowest *f* value and set that as the current node. Next from the current node we check the adjacent nodes for their *g* and *h* values. If there is a node that is in the open list that is adjacent to the current node that has previous *g* and *h* values from a previous current node we check to see if the new *g* and *h* values are lower; if they are we change the parent of that node to the current node else we leave it. We then continue calculating all the *g* and *h* values of all the adjacent nodes and set the current node to the one that has the lowest *f* value. We continue doing this recursively until we reach the destination.

Once we reach the destination we track back from the node to its parent until we reach the origin; this generates the path.

To demonstrate this lets look at the following grid.

			Wall			
	Origin		Wall		Target	
			Wall			

Each box is a node; we start from the origin and want to get to the target. The current node is marked in **bold**.

8 30 ↓→ 38	5 25 ↓ 30	8 20 ↓← 28	Wall			

5 25 → 30	**Origin**	5 15 ← 20	Wall		Target	
8 30 ↑→ 38	5 25 ↑ 30	8 20 ↑← 28	Wall			

We mark all the adjacent nodes to the origin with their *g*, *h*, and *f* values and an arrow to who the parent node is. (I could not find a diagonal arrow so I used two arrows.) We then move to the node that has the lowest *f* value and set that node as the current node and close the Origin node, marked in *italics*.

8 30 ↓→ 38	5 25 ↓ 30	8 20 ↓← 28	Wall			
5 25 → 30	*Origin*	**5 15** ← **20**	Wall		Target	
8 30 ↑→ 38	5 25 ↑ 30	8 20 ↑← 28	Wall			

Now we check the nodes around the current node. We can't go forward or backwards, so we test up and down and diagonals. Since all of the *f* values are higher then the current ones we leave everything. (For example the node below the current *g* is 10 (current node + move) and *h* is 20 so *f* is 30.) Next we look for the lowest *f* value; now we can go either up or down so pick one and continue. Keep doing this until you reach the destination.

Since this algorithm works with estimations it does not always produce a perfect path. For example, if the wall was one node higher the algorithm can choose up instead of down and it will take a little longer.

Once you reach the target we trace back using the arrows to create the shortest path. The reason we have to trace back is that not every node that was a current node will be part of the path. For example, the first move we moved was forward; since we did not change any of the parent pointers (to point to this node) we did not use this node for the path.

Let's say we do not know where the destination is, how do we search for it? The solution is to set the *h* value to 0 thereby expanding out from the origin equally in all directions until we find the destination; this is Dijkstra's Algorithm. This algorithm uses up much more computing power then A* because it searches more nodes then A*; but it has its applications. For example, if we don't know where the destination is or there are multiple possible destinations, instead of running A* multiple time we can run Dijkstra's Algorithm once.

3DGameStudio A* Implementation

Level Design

To implement this into 3DGameStudio we will use the entity node method for the nodes. First create a level in the WED; next we place entities (they can be simple squares) through out the WED making sure that every spot in the level can see an entity and every entity can see another entity. (These entities will now be referred to as nodes.) This way the enemy can find the player no matter where the player is in the level.

C-Script

Now we have to change the enemy's code to implement the path finding algorithm. First we will add a local variable that will be used as a flag.

```
var player_spotted = 0;
```

This variable is set to 1 when the enemy traces the player or when the enemy loses healthpoints. Once this variable is set to 1 the enemy will use path finding to track down the player.

Next in the continue patrol code we have to add an if else statement.

```
if ((! player_spotted))
{
	vec_set(temp, node_pos.x);
	vec_sub(temp, my.x);
	vec_to_angle(my.skill10, temp);

	my.pan = my.skill10.pan;
	my.tilt = my.skill11.tilt;

	temp.x = 5 * time;
	temp.y = 0;
```

```
        temp.z = 0;
        c_move (my, temp, nullvector, IGNORE_YOU + IGNORE_PASSABLE +
        IGNORE_PUSH + ACTIVATE_TRIGGER + GLIDE);
}
```

Now if the "player_spotted" flag was not triggered continue patrolling, else path find.

```
else
{
        dst_ent = player;

        if ( pf_to_ent(my, dst_ent) )
        {
                turn_speed = 15 * time;
                direction_vec.pan  = my._PF_PAN_TO_TARGET;
                direction_vec.tilt = my._PF_TILT_TO_TARGET;
                direction_vec.roll = my._PF_ROLL_TO_TARGET;

                if (PATH_SMOOTHING)
                {
                        pf_smooth_turn(my,VECTOR(my._PF_PAN_TO_TARGET,
                        my._PF_TILT_TO_TARGET,my._PF_ROLL_TO_TARGET),
                        turn_speed);
                }
                else
                {
                        vec_set(my.pan, direction_vec.pan);
                }
                if(my._PF_REACHED_TARGET == 0)
                {
                        move_mode = IGNORE_PASSABLE + GLIDE;
                        ent_move(vector(time * 15,0,0), nullvector);
                }
        }
}
```

This is the heart of the path finding for the game. This is how it works. "dst_ent = player" places the player entity into "dst_ent". Next "pf_to_ent(my, dst_ent)" sends two parameters to "pf_to_ent". The first parameter is the starting position (the enemy) and the second parameter is the destination (the player). "pf_to_ent" works by doing a trace directly to the target. If there is no collisions it knows that the player is in sight and exits else in records the distance. It then searches for the nodes near the origin and searches for one that is closer then the current node to the destination. It also calculates the distance between the current node and the next node. It takes these two numbers and adds them

together to find the neighbor node with the lowest number. It keeps on calculating the nodes until it reaches the node closest to the player and then it has a path.

All the nodes are linked together in the beginning of the game using the "pf_init_nodes()" function. It traces each node to the next and records the position and the total number of neighbors and sorts them by distance. It then stores all the nodes using bubble sort so they can be retrieved when "pf_to_ent is called.

Alternate Path Finding

There is another interesting way to implement path finding. Instead of calculating the path each time the player moves to a different node we can calculate the distances between all the nodes before the game. This cuts down the calculation time tremendously. The problem with this method is that if the level changes, lets say a door closes, we will have a problem calculating a new route. For that reason we used the traditional A* path finding.

GLOSSARY

Bump Mapping This is used to create a scene that has different depths (such as a rocky wall) without actually creating it. The way this works is that the different depths are stored into a texture and then applied to the surface of the level.

BSP Tree BSP stands for binary space partitioning, this tree partitions space by dividing it using a splitting plane. The tree can be built for a two or three dimensional level. 3DGameStudio always builds a three dimensional tree. This tree was introduced by Fuchs (1980).

Geometric LOD LOD stands for levels of detail. This method is usually used in wide open areas (for example a large landscape), it lowers the level of detail on objects that are far and as they get closer the detail improves. This allows the view to have many objects in it with a minimum amount of rendering.

HLSL/Cg is a c based language that is used for vertex and pixel shading.

MIP Map MIP stands for multum in parvo which is Latin for "much in little". This method changes the detail of textures as they get farther away from the player.

Player The term "Player" when referred to in this document and in 3DGameStudio is the entity model that the user controls.

Portal Is a view that is mapped onto a surface of the level map.

Portal and Frustum Culling removes scenes from being rendered. This keeps the rendering to only the current view.

PVS stands for potential visible sets. This method is used to choose which faces from the BSP tree should be rendered for the current view.

Quant is a measurement used in 3DGameStudio.

Sky Cube Is a six sided cube that surrounds a level, created from six different images to simulate a sky.

Sprite is a two dimensional image that is either placed on a wall (a decal) or can be set to always face the camera thereby simulating a three dimensional object.

Viewing Frustum Is the visible part of the level at the exact time that the user is playing the game. In a standard three dimensional game this is usually a virtual cone shape.

APPENDIX A

The Ackermann Function in C-Script

Appendix A is the Ackermann function written in C-Script. The purpose of this program is to display the basic layout of C-Script.

To run this program you need a dark texture for the background.

```
// CScript.wdl

var video_mode = 7; // 800x600 pixels
var video_depth = 32; // 32 bit mode

var a = 1;
var b = 2;
var c = 0;

string CScript_wmb = <CScript.wmb>;

text box
{
	pos_x = 10;
	pos_y = 10;
	string = "a = \nb = \nackermann = ";
	flags = visible;
}

panel display_pan
{
	pos_x = 0;
	pos_y = 0;
	digits = 35, 10, 3, _a4font, 1, a;
	digits = 35, 19, 3, _a4font, 1, b;
	digits = 80, 28, 3, _a4font, 1, c;
	flags = overlay, refresh, visible;
}

function ack(a,b){
	if(a==0){
		return (b+1);
	}
	if(b==0 && a!=0){
		return (ack(a-1,1));
	}
	else{
		return (ack(a-1,ack(a,b-1)));
```

```
	}
}

function main()
{
	level_load (CScript_wmb);
	while (1)
	{
		c=ack(a,b);
		wait (1);
	}
}
```

APPENDIX B

Entity Movement Using C-Script

Appendix B demonstrates how to move entities in a level using C-Script.

To run this program you need the code from Chapter 4 and replace the action with this appendix. You also need any texture for the level and one entity for the movements, preferable some kind of spaceship or hovercraft.

```
action ship
{
	while(1)
	{
		if(key_w == on)
		{
			my.x = my.x+1;
		}
		if(key_s == on)
		{
			my.x = my.x-1;
		}
		if(key_a == on)
		{
			my.y = my.y+1;
		}
		if(key_d == on)
		{
			my.y = my.y-1;
		}
		if(key_z == on)
		{
			my.z = my.z+1;
		}
		if(key_x == on)
```

```
        {
            my.z = my.z-1;
        }
        if(key_i == on)
        {
            my.tilt = my.tilt+1;
        }
        if(key_k == on)
        {
            my.tilt = my.tilt-1;
        }
        if(key_j == on)
        {
            my.pan = my.pan+1;
        }
        if(key_l == on)
        {
            my.pan = my.pan-1;
        }
        if(key_m == on)
        {
            my.roll = my.roll+1;
        }
        if(key_n == on)
        {
            my.roll = my.roll-1;
        }
        wait(1);
    }
}
```

APPENDIX C

Entity Movement Implementing Collision Detection

Appendix C demonstrates how to move an entity in C-Script using collision detection.

To run this program you need the program from Chapter 4 and replace the action with this appendix. You also need any texture for the level and one entity for the movements, preferable some kind of spaceship or hovercraft.

```
action ship
{
	while(1)
	{
		if(key_w == on)
		{
			c_move(my,vector(5*time,0,0), nullvector,glide);
		}
		if(key_s == on)
		{
			c_move(my,vector(-5*time,0,0), nullvector,glide);
		}
		if(key_a == on)
		{
			c_move(my,vector(0,5*time,0), nullvector,glide);
		}
		if(key_d == on)
		{
			c_move(my,vector(0,-5*time,0), nullvector,glide);
		}
		if(key_z == on)
		{
			c_move(my,vector(0,0,5*time), nullvector,glide);
		}
```

```
            if(key_x == on)
            {
                  c_move(my,vector(0,0,-5*time), nullvector,glide);
            }
            if(key_i == on)
            {
                  c_rotate(my,vector(0,5*time,0),glide);
            }
            if(key_k == on)
            {
                  c_rotate(my,vector(0,-5*time,0),glide);
            }
            if(key_j == on)
            {
                  c_rotate(my,vector(5*time,0,0),glide);
            }
            if(key_l == on)
            {
                  c_rotate(my,vector(-5*time,0,0),glide);
            }
            if(key_m == on)
            {
                  c_rotate(my,vector(0,0,5*time),glide);
            }
            if(key_n == on)
            {
                  c_rotate(my,vector(0,0,-5*time),glide);
            }
            wait(1);
      }
}
```

APPENDIX D

Entity Rotations and Camera angles

Appendix D demonstrates how to rotate an entity with the rotation based on the entity instead of the level. This is very useful for flying games which require the user to fly some kind of ship. This also demonstrates how to set up a camera in a certain angle and move it along with an entity using C-Script.

To run this program you need any texture for the level and one entity for the movements, preferable some kind of spaceship or hovercraft.

```
// Movement.wdl

var video_mode = 7; // 800x600 pixels
var video_depth = 32; // 32 bit mode
var video_screen = 1;

var cam_pos[3];
var cam_ang[3];

string Movement_wmb = <Movement.wmb>; //string with level name to load level

function view_ship() {
    // set all to 0 if you want to be in the ship
    vec_set(cam_pos,vector(-100,0,25));
    vec_rotate(cam_pos,my.pan);
    vec_add(cam_pos,my.x);
    vec_set(camera.x,cam_pos);
    vec_diff(cam_ang,my.x,camera.x);
    vec_to_angle(camera.pan,cam_ang);
    camera.tilt = my.tilt;
    camera.roll = my.roll;
    camera.pan = my.pan;
    //camera.genius = my; //this makes the ship invisible
```

```
}

action ship
{
	while(1)
	{
		temp.x +=15 * (key_w - key_s)*time;
		temp.y +=15 * (key_a - key_d)*time;
		temp.z +=15 * (key_z - key_x)*time;

		c_move(my,vector(temp.x,temp.y,temp.z),nullvector,glide);

		vec_set(temp.pan,vector(0,0,0));
		temp.pan += 5 * (key_j - key_l) * time;
		temp.roll += 5 * (key_n - key_m) *time;
		temp.tilt += 5 * (key_k - key_i) * time;

		vec_to_angle(temp.pan,nullvector);
		ang_add(temp.pan,my.pan);
		vec_diff(temp.pan,temp.pan,my.pan);
		c_rotate(my,temp.pan,glide);

		view_ship();

		wait(1);
	}
}

function main()
{
	level_load (Movement _wmb); //load level
	wait(3); //wait three cycles for level to load
}
```

APPENDIX E

3D Game Implementing Entity Animations and Effects

This is a basic first person shooter game. It demonstrates how to how to move an entity with animations, player sound files, and implement special effects. This program requires a texture for the level, two entities one used for the bad guys and one used for the player, five sound files and three picture file for the special effects.

```
// Movement.wdl


var video_mode = 7; // 800x600 pixels
var video_depth = 32; // 32 bit mode
var video_screen = 1;


var cam_pos[3];
var cam_ang[3];


var anim_cycle;
var anim_speed=2; //animation speed


var im_shot=0; //flag if Witch was shot


sound wham_wav = <wham.wav>;
sound beamer_wav = <beamer.wav>;
sound scream_wav = <scream.wav>;
sound witch_wav = <witch.wav>;


define healthpoints = skill1;


entity* ent_pointer;                // used in effects routines
bmap explosion_particle_map = <fireball_sprite.pcx>;


string Movement_wmb = <Movement.wmb>; //string with level name to load level
```

```
function remove_func();
function im_hit();
function shoot_action;
function shoot();

function main()
{
	level_load (Movement _wmb); //load level
	wait(3); //wait three cycles for level to load
	media_loop("hauntedmansion.mid",null,50);
}
//used in first shooter game
function view_warlock() {
	 // set all to 0 if you want to be in the ship
	vec_set(cam_pos,vector(0,0,0));
	vec_rotate(cam_pos,my.pan);
	vec_add(cam_pos,my.x);
	vec_set(camera.x,cam_pos);
	vec_diff(cam_ang,my.x,camera.x);
	vec_to_angle(camera.pan,cam_ang);
	camera.tilt = my.tilt;
	camera.roll = my.roll;
	camera.pan = my.pan;
	camera.genius = my; //this makes the entity invisible
}

function im_hit()
{
	if(my.healthpoints>0)
	{
		my.healthpoints -=10;
		im_shot = 1;
	}
```

```
}

function remove_func()
{
  wait(1); // make sure it exist at least one frame

  small_explosion(handle(my));
  my.invisible=on;
  my.passable=on;
  ent_playsound(my, wham_wav, 1000);
  sleep(.5);
  ent_remove(me);
}

function explosion_fade()
{
        my.alpha -= 20 * time;
        if(my.alpha < 0) { my.lifespan = 0; }
}

function small_explosion_particle
{
        var velocity_vec[3];
        velocity_vec[0] = random(4) - 2;
        velocity_vec[1] = random(4) - 2;
        velocity_vec[2] = random(4) - 2;
        vec_set(my.vel_x, velocity_vec.x);
        my.move = on;
        my.bmap = explosion_particle_map;
        my.alpha = 80;
        my.lifespan = 100;
        my.size = 10;
        my.flare = 1;
```

```
	my.function = explosion_fade;
}

function small_explosion(entity_handle)
{
	var pos_vec[3];
	var count = 10;

	ent_pointer = ptr_for_handle(entity_handle);

	if (ent_pointer != null)
	{
		vec_set(pos_vec, ent_pointer.x);
		pos_vec.x += (random(6) - 3);
		pos_vec.y += (random(6) - 3);
		pos_vec.z += (random(6) - 3);
	}

	while (count > 0)
	{
		effect(small_explosion_particle, 2, pos_vec.x, nullvector);
		count -= 1;
	}
}

function shoot()
{
	while(my.healthpoints>0)
	{
		if(key_space==on)
		{
			ent_create("blue.bmp",player.x,shoot_action);
			sleep(.3);
```

```
                }
                wait(1);
        }
}

function shoot_action()
{
  my.enable_impact = on;
  my.enable_entity = on;
  my.enable_block = on;
  my.enable_stuck = on;
  my.event = remove_func;
  my.pan = you.pan;
  my.tilt = 0;
  my.roll = 0;
  my.passable = off;
  my.facing = on;
  my.overlay = on;

  ent_playsound(my, beamer_wav, 100);

  while(1)
  {

c_move(my,vector(10*time,0,0),nullvector,activate_trigger+ignore_passents+ignore_pas
sable+ignore_me+ignore_you);
    wait(1);
  }
}

action warlock
{
        player = me;
```

```
my.enable_impact = on;
my.enable_entity = on;
my.event = im_hit;
my.healthpoints=100;
shoot();
while(my.healthpoints>0)
{
	var move_x=0;
	var move_y=0;
	var rotate;
	if(key_any == off)
	{
		ent_animate(my,"stand",anim_cycle,anm_cycle);
		anim_cycle += anim_speed * time;
	anim_cycle %= 100;
	}
	if(key_w==on || key_s==on || key_z==on || key_x==on)
	{
		move_x += 5*(key_w - key_s)*time;
		move_y += 5*(key_z - key_x)*time;
		ent_animate(my,"walk",anim_cycle,anm_cycle);
		anim_cycle += anim_speed * time;
	anim_cycle %= 100;
	}

	c_move(my,vector(move_x,move_y,0),nullvector,IGNORE_YOU +
IGNORE_PASSABLE + IGNORE_PUSH + ACTIVATE_TRIGGER + GLIDE);
	if(key_a==on || key_d==on)
	{
		rotate += 5*(key_a - key_d)*time;
		ent_animate(my,"walk",anim_cycle,anm_cycle);
		anim_cycle += anim_speed * time;
	anim_cycle %= 100;
```

```
		}

	c_rotate(my,vector(rotate,0,0),activate_trigger+ignore_passents+ignore_passable
+ignore_me+ignore_you+ignore_sprites+glide);


		wait(1);
	}
	ent_playsound(my,witch_wav,1000);
	temp=0;
	while(temp < 75 && my.healthpoints<=0)
	{
		ent_animate(my,"death",temp,0);
		temp+=2*time;
		wait(1);
	}
}

action witch
{
	my.enable_impact = on;
	my.enable_entity = on;
	my.event = im_hit;
	my.healthpoints = 30;

	while(my.healthpoints>0)
	{
		ent_animate(my,"stand",anim_cycle,anm_cycle);
		anim_cycle += anim_speed * time;
	anim_cycle %= 100;
	//if I was shot and the Wizard is alive kill him
	if(im_shot==1 && player.healthpoints > 0)
	{
		vec_set(temp,player.x);
```

```
                vec_sub(temp,my.x);
        vec_to_angle(my.pan,temp);
        ent_create("red.bmp",my.x,shoot_action);
        sleep(1);
    }
        wait(1);
    }
    temp=0;
    ent_playsound(my, scream_wav, 1000);
    while(temp <= 100 && my.healthpoints<=0)
    {
        my.passable=on;
        ent_animate(my,"death",temp,0);
        temp+= 2*time;
        wait(1);
    }
}
```

APPENDIX F

A 3D Game Implementing Advanced AI and Effects

This program contains all the code needed to create the core of a full functioning game. To complete this program and create a commercial game it requires menus, multiple levels, and a final goal for the player to complete.

The sound files can be created using any program that can create wav, mid, ogg, CD, mp3, avi, and mpg. These files can either be created on a computer using a digital synthesizer, recorded from a microphone, or ripped from a CD.

Models implemented in this program can be created in any 3D modeling program this includes Maya, Truespace, and 3D Studio Max. Conitec offers a free plugin for Maya and 3D Studio Max so the models can be imported seamlessly.

Textures can be created by using any kind of graphic program that can create bmp files. These programs include Microsoft Paint which is free with any version of MS Windows and is a very basic graphic program to programs like Adobe PhotoShop which is an advanced image editing software package.

The path finding code is implemented by importing a dll file into the game engine. This file was created using VC++ and the SDK plugin for 3DGameStudio. The plugin can be downloaded from http://conitec.com/a4update.htm. By using VC++ you have the full power of C++ programming to produce your game. The reason why the path finding code is implemented using C++ is that in C-Script you can not have different classes thereby making it impossible to define a node class. C++ on the other hand allowed the node class to be created thereby making the path finding code much easier to write and much more efficient.

```
// Project.wdl
//
// command line parameters
//
// -d no_enemy_fire          Enemies no longer fire weapons.  Good for testing!
//


var video_mode = 7;          //1024x768 screen
var video_depth = 16; //16 bit
var video_screen = 1; //full screen


// DLL Handles
```

```
var pathfind_handle;

// Other global variables

var temp_vec;                    //for ship movement

var cam_pos[3];                  //for view_ship
var cam_ang[3];

var i=0;                                        //for patrol_path

entity* bad_guy;
entity* ent_pointer;          // used in effects routines
entity* src_ent;                 // used in pathfinding routines
entity* dst_ent;                 // used in pathfinding routines

string tmp_string;            // for diagnostic messages

string bullet_blue = <blue.bmp>; //for player's bullet
string bullet_red = <red.bmp>;   //for enemy's bullet
string bullet_hole = <bullet_hole.bmp>;

bmap crosshair_bmp = <crossHair.bmp>;
bmap ptrail_map = <ptrail.pcx>; //for rocket

bmap explosion_particle_map = <fireball_sprite.pcx>;

string rocket_mdl = <rocket.mdl>;

sound rocket_wav = <rocket.wav>;
sound destroyed_wav = <destroyed.wav>;
sound beamer_wav = <beamer.wav>;
sound wham_wav = <wham.wav>;
```

```
define number_of_edges, 10;

//=============Code for .dll file=====================
// this code lists all the functions imported from the dll file

DEFINE _PF_NEXT_NODE_X, skill91;
DEFINE _PF_NEXT_NODE_Y, skill92;
DEFINE _PF_NEXT_NODE_Z, skill93;
DEFINE _PF_REACHED_TARGET, skill94;
DEFINE _PF_TARGET_IN_SIGHT, skill95;

DEFINE _PF_PAN_TO_TARGET, skill96;
DEFINE _PF_TILT_TO_TARGET, skill97;
DEFINE _PF_ROLL_TO_TARGET, skill97;

DEFINE _NODE_LOCKED, skill99;
DEFINE _PATH_BLOCKED, skill100;

dllfunction pf_initialized();
dllfunction pf_init_nodes();
dllfunction pf_first_node();
dllfunction pf_to_ent(src_ent, dst_ent);

dllfunction pf_use_los(flag);
dllfunction pf_set_ent_collision_distance(dist);
dllfunction pf_set_max_path(dist);
dllfunction pf_set_node_collision_distance(dist);
dllfunction pf_set_diag(flag);

dllfunction pf_smooth_tilt(flag);
dllfunction pf_smooth_roll(flag);
```

```
dllfunction pf_diag_node(ent_pointer);
dllfunction pf_next_node(src_ent_ptr, dst_ent_ptr);
dllfunction pf_smooth_turn(actor_ent_ptr, pan_vec, speed);

bind <pathfind.dll>;


// =========== DEFINES ==========================================
// Create constants for the player's ship's skills

//used for player's movement
define _FORCE_X, skill20;
define _FORCE_Y, skill21;
define _FORCE_Z, skill22;

//used for player's rotation
define _FORCE_PAN, skill23;
define _FORCE_TILT, skill24;
define _FORCE_ROLL, skill25;

define healthpoints = skill1;              // just another name for skill1

define _TYPE, skill4;                                  // Type of entity.  See below for type
defines.
define _DAMAGE, skill5;                                    // Damage done by missile or
bullet
define _TARGET_LOCKED, skill6;             // Flag for heat seeking missiles.  1= locked
on target

// Define entity types

define PLAYER_TYPE, 1;
define ENEMY_TYPE, 2;
```

```
define PLAYER_BULLET_TYPE, 3;
define PLAYER_ROCKET_TYPE, 4;
define ENEMY_BULLET_TYPE, 5;
define SPACE_DEBRIS_TYPE, 6;


define DEBRIS_LIFETIME, 15;                    // How long it takes until debris
explodes
define PATH_SMOOTHING, 1;                      // Decide wether or not to
smooth out pathfinding turns
define SOUND_ALARM, 0;                         // Setting this causes all
enemy ships to begin hunting the player

// =========== FUNCTION PROTOTYPES
========================================


function rocket_action();
// function remove_rocket();
function particle_trail();
function fade_trail();
function view_ship();
function enemy_event();
function im_hit_player();
function radar();
function shoot_action();
function shoot_action_player();
function space_fire();



// =========== CODE ============================================


function main() {
```

```
	pathfind_handle		= dll_open("pathfind.dll");

	wait(3);

	warn_level = 0; // This is necessary for the .dll to work

	fps_max = 60;
	clip_size =0;
	level_load("Project.wmb");

	wait(3);

	cd_play(4,4);

	// Set the node collision distance to 40.
	//Make it smaller if pf_smooth_turn is not in use

	pf_set_node_collision_distance(40);

	// Allow pf_smooth_turn to modify tilt and roll parameters:

	pf_smooth_tilt(on);
	pf_smooth_roll(on);

	// Initialized pathfinding nodes.  Do this after the level loads.  The
	// .dll function pf_initialized() returns 1 when the pathfinding has completed
	// initialization.

	pf_init_nodes();

	wait(1);
}
```

```
//keeps camera in the center of an entity
function view_ship()
{
	vec_set(cam_pos,vector(0,0,0)); //the vector can be changed to change the view
	vec_rotate(cam_pos,my.pan);
	vec_add(cam_pos,my.x);
	vec_set(camera.x,cam_pos);
	vec_diff(cam_ang,my.x,camera.x);
	vec_to_angle(camera.pan,cam_ang);
	camera.tilt = my.tilt;
	camera.roll = my.roll;
	camera.pan = my.pan;
	camera.genius = my; //make ship invisible
}

string tmp_str;

function rocket_event()
{

	var remove_rocket = 0;

	// If the rocket hit an entity, and that entity was an enemy, then
	// reduce the enemy's health points and remove the rocket.

	if (EVENT_TYPE == EVENT_ENTITY)
	{
		if ((my._TYPE == PLAYER_ROCKET_TYPE) && (you._TYPE ==
ENEMY_TYPE))
		{
			you.healthpoints -= my._DAMAGE;
			remove_rocket = 1;
```

```
		}
		if ((my._TYPE == PLAYER_ROCKET_TYPE) && (you._TYPE == PLAYER_ROCKET_TYPE))
		{
			remove_rocket = 1;
		}
	}

	// If the rocket his part of the level, the remove the rocket.

	if (EVENT_TYPE == EVENT_BLOCK)
	{
		remove_rocket = 1;
	}

	if (remove_rocket)
	{

		ent_playsound(my, destroyed_wav, 1000); // play the explosion sound
		small_explosion(handle(my));

		my.event = null;
		my.invisible = on; // hide the rocket
		my.passable = on;

		sleep(1); //keep ent_playsound playing for one second

		ent_remove(me); // now remove it
	}
	wait(1);
}

function bullet_event()
```

```
{
	var explode_flag = 0;

	if (EVENT_TYPE == EVENT_ENTITY)
	{
		if ((my._TYPE == PLAYER_BULLET_TYPE) && (you._TYPE == 
ENEMY_TYPE))
		{
			you.healthpoints -= my._DAMAGE;
		}

		if ((my._TYPE == ENEMY_BULLET_TYPE) && (you._TYPE == 
PLAYER_TYPE))
		{
			you.healthpoints -= my._DAMAGE;
		}
	}


	// Ignore space debris, other bullets, and the player

	if (EVENT_TYPE == EVENT_ENTITY)
	{
		if (my._TYPE == PLAYER_BULLET_TYPE)
		{
			if ((you._TYPE == SPACE_DEBRIS_TYPE) ||
				(you._TYPE == PLAYER_BULLET_TYPE) ||
				(you._TYPE == ENEMY_BULLET_TYPE) ||
				(you._TYPE == PLAYER_ROCKET_TYPE) ||
				(you._TYPE == PLAYER_TYPE))
			{
				return;
			}
```

```
		}
	}


	// If the player moves into the bullet, then ignore it

	if (EVENT_TYPE == Event_impact)
	{
		if (you._TYPE == PLAYER_TYPE)
		{
			return;
		}
	}
	snd_play (wham_wav, 50,0);

	small_explosion(handle(my));
		wait(1);
	ent_remove(me);
}


function enemy_event()
{
	if (EVENT_TYPE == EVENT_SCAN)
	{
		// Enemy got scanned by a rocket

		if (you._TYPE == PLAYER_ROCKET_TYPE)
		{
			if (my.invisible == off)
			{
				vec_set (temp.x, my.x);
				vec_sub (temp.x, you.x);
```

```
                                vec_to_angle (you.pan, temp.x);        // rotate the missile
towards me

                                you._TARGET_LOCKED = on;                        // lock
on heat seeking missile
                        }
                }
        }


        // Enemy moved into a rocket.

        if (EVENT_TYPE == EVENT_ENTITY)
        {
                if (you._TYPE == PLAYER_ROCKET_TYPE)
                {
                        diag("\nWARNING - enemy moved into a rocket.");
                }
        }

        // If the enemy ship was run into by another enemy ship, then get pushed by
        // the ship that was moving.

        if (EVENT_TYPE == EVENT_IMPACT)
        {
                if (you._TYPE == ENEMY_TYPE)
                {
                        move_mode = IGNORE_PASSABLE + GLIDE;

                        // Get pushed
                        ent_move(nullvector, normal);

                        // Also move forward a little to make room.
```

```
                ent_move(VECTOR(10 * time, 0,0), nullvector);

                // Also move forward a little to make room.
                ent_move(VECTOR(0,0, 10 * time), nullvector);
            }
        }
}

function im_hit_player()
{

        var abs_force_vec[3];
        var rel_force_vec[3];

        if (EVENT_TYPE == EVENT_BLOCK)
        {
            return;
        }
        wait(1);
}

function remove_func()
{
        if(event_type == event_block)
        {
            ent_create(bullet_hole,my.x,null);
        }
        wait(1); // make sure it exist at least one frame
        ent_remove(me); //remove it
}

function shoot_action()
{
```

```
	// Set up events
	my.enable_impact = on;
	my.enable_entity = on;
	my.enable_block = on;
	my.enable_stuck = on;
	my.event = bullet_event;

	// Turn to face in the same direction as the entity who fired me
	my.pan = you.pan;
	my.tilt = you.tilt;
	my.roll = you.roll;

	my.passable = off;
	my.facing = on;
	my.overlay = on;

	my._DAMAGE = 10;                                    // Set the amount of damage this bullet does
	my._TYPE = ENEMY_BULLET_TYPE; // Set the type of entity, used in event routine

	ent_playsound(my,beamer_wav,100);

	while(my != null)
	{
		temp.x = 20 * time;
		temp.y = 0;
		temp.z = 0;

		result = c_move(my,temp,nullvector,activate_trigger+ignore_passents+ignore_passable+ignore_me+ignore_you+ignore_sprites);

		wait(1);
```

```
	}
}


// This routine is called when the player hits the space bar.  It fires a bullet
// in the form of a sprite directly ahead.

function shoot_action_player()
{
	my.enable_impact = on;
	my.enable_entity = on;
	my.enable_block = on;
	my.enable_stuck = on;
	my.event = bullet_event;

	my.pan = player.pan;
	my.tilt = player.tilt;
	my.roll = player.roll;

	my.passable = off;
	my.facing = on;
	my.overlay = on;

	my._TYPE = PLAYER_BULLET_TYPE;		// Set the entity type, used in event routine
	my._DAMAGE = 10;					// Set the damage done by this bullet

	ent_playsound(my,beamer_wav,50);

	while(my != NULL)
	{
```

```
		temp.x = 20 * time;
		temp.y = 0;
		temp.z = 0;

		result =
c_move(my,temp,nullvector,activate_trigger+ignore_passents+ignore_passable+ignore_
me+ignore_you);

		my.roll= my.roll + 100;

		wait(1);
	}

	wait(1);
}

function space_fire()
{

	while(player.healthpoints > 0)
	{
		if(key_space == on)
		{
			ent_create(bullet_blue,player.x,shoot_action_player);
			sleep(.5);
		}
		wait(1);
	}

	wait(1);
}
```

```
function rocket_action
{
	my.enable_entity = on;
	my.enable_block = on;
	my.event = rocket_event;

	my.pan = you.pan;
	my.tilt = you.tilt;
	my.roll = you.roll;

	my.skill95 = 0;
	my.skill91 = 20;
	my.skill92 = 0;
	my.skill93 = 0;
	my.skill91 *= time;
	my.skill90 = 0;

	my._TARGET_LOCKED = off;
	my._TYPE = PLAYER_ROCKET_TYPE;
	my._DAMAGE = 10;


	while (my.skill95 < 500)
	{
		if (my == null) {return;}

		if (my.invisible == off)
		{
			temp.x = 360; // horizontal scanning angle
			temp.y = 60; // vertical scanning angle
			temp.z = 1000; // scanning range
```

```
                    if ((my._TARGET_LOCKED == off) && (vec_dist (my.x,
player.x) > 100))
                    {
                        scan_entity(my.x, temp);
                    }

                    my.skill95 += 1 * time;



                    //used to keep the player from getting hit by its own missle
                    you = player;

                    // Move the rocket.

                    result = c_move(my, my.skill91, nullvector, ignore_me +
ignore_you + ignore_passable);

                    temp.x = my.x - 6 * cos(my.pan);
                    temp.y = my.y - 6 * sin(my.pan);
                    temp.z = my.z;

                    effect(particle_trail, 10, temp, normal);
                }
                wait(1);
            }

            // Remove rocket

            ent_playsound(my, destroyed_wav, 1000); // play the explosion sound
            small_explosion(handle(my));

            my.event = null;
            my.invisible = on; // hide the rocket
```

```
	my.passable = on;

	sleep(1);  //keep ent_playsound playing for one second

	ent_remove(me); // now remove it

}


function particle_trail()
{
	temp.x = random(2) - 1;
	temp.y = random(2) - 1;
	temp.z = random(2) - 1;
	vec_rotate (temp, my.pan);
	vec_normalize (temp, 3);
	vec_add (my.vel_x, temp);
	my.alpha = 40 + random(30);
	my.bmap = ptrail_map;
	my.size = random(2) + 5;
	my.flare = on;
	my.bright = on;
	my.beam = on;
	my.move = on;
	my.lifespan = 20;
	my.function = fade_trail;
}

function fade_trail()
{
	my.alpha -= 10 * time;
	if (my.alpha < 0) {my.lifespan = 0;}
}
```

```
action ship
{
	// Wait for pathfinding nodes to get initialized

	while(! pf_initialized())
	{
		wait(1);
	}

	// fire_key_clear will act as a flag that shows the status of the fire key.
	// It's used to make sure code is only run once when the fire key is pressed.


	var fire_key_clear = 1;

	// The following constants control the speed of the ship

	var ACCELERATION_SPEED = .4;		// Speed factor that ship accelerates
	var DECELERATION_SPEED = .4;		// Speed factor that ship decelerates
	var PAN_ACCELERATION_SPEED = .3;	// Speed factor that ship accelerates pans/tilts/roll
	var PAN_DECELERATION_SPEED = .2;	// Speed factor that ship decelerates pans/tilts/roll
	var TOP_SPEED = 5;				// Top speed of ship
	var TOP_ROTATION_SPEED = 1.5;			// Limits pan/tilt/and roll speeds

	// SHIP_CALM is the minimum speed that the ship has
	// to move to be considered moving.

	var SHIP_CALM = .05;
```

```
var SHIP_CALM_PAN = .05;

// Set up events

my.enable_impact = on;                    // Player was hit by another entity
my.enable_entity = on;                    // Player hit another entity
my.enable_block = on;                     // Player hit a level block

my.event = im_hit_player;

// Set type to PLAYER_TYPE.  This is an identifier that's used in the events code
// to help specify what actions should be taken during, say, an event_entity.

my._TYPE = PLAYER_TYPE;

// Set player entity's attributes

player = me;
player.healthpoints = 100;
//my.invisible = on;

my.narrow = on; //used for collision detection
my.fat = on;
c_setminmax(my);

space_fire();

while(player.healthpoints > 0)
{

        // Poll the movement keys. If any of the movement keys are pressed, then
apply

        // force to the ship.  Three of the ship's skill slots will be used to store
```

```
// a vector representing the relative forces on the ship: x, y, z = relative
// to the ship's facing.
//
// The forces will be stored in the following slots:
// my._FORCE_X;
// my._FORCE_Y;
// my._FORCE_Z;

if (key_a)    { my._FORCE_X += time * ACCELERATION_SPEED; }
if (key_z)    { my._FORCE_X -= time * ACCELERATION_SPEED; }
if (key_end)  { my._FORCE_Y += time * ACCELERATION_SPEED; }
if (key_pgdn) { my._FORCE_Y -= time * ACCELERATION_SPEED; }

// Decelerate if keys are not pressed

if ((key_a == off) && (key_z == off) && (abs(my._FORCE_X) >
SHIP_CALM))
{
        my._FORCE_X -= (sign(my._FORCE_X) * time *
DECELERATION_SPEED);

        if (abs(my._FORCE_X) < SHIP_CALM)
        {
                my._FORCE_X = 0;
        }
}

if ((key_end == off) && (key_pgdn == off) && (abs(my._FORCE_Y) >
SHIP_CALM))
{
        my._FORCE_Y -= (sign(my._FORCE_Y) * time *
DECELERATION_SPEED);

        if (abs(my._FORCE_Y) < SHIP_CALM)
```

```
                {
                        my._FORCE_Y = 0;
                }
        }

        // Ensure that the ship doesn't go over the top speed.

        my._FORCE_X = clamp(my._FORCE_X, -1 * TOP_SPEED,
TOP_SPEED);
        my._FORCE_Y = clamp(my._FORCE_Y, -1 * TOP_SPEED,
TOP_SPEED);
        my._FORCE_Z = clamp(my._FORCE_Z, -1 * TOP_SPEED,
TOP_SPEED);

        // Now handle pan/tile/and roll controls.  These will be very similar to the
        // movement controls.  The forces will be stored in the following slots:
        // my._FORCE_PAN, my._FORCE_TILT, my._FORCE_ROLL

        // Add forces to PAN

        if (key_cul) {  my._FORCE_PAN += time *
PAN_ACCELERATION_SPEED; }
        if (key_cur) {  my._FORCE_PAN -= time *
PAN_ACCELERATION_SPEED; }

        // Add forces to TILT

        if (key_cud) { my._FORCE_TILT += time *
PAN_ACCELERATION_SPEED; }
        if (key_cuu) { my._FORCE_TILT -= time *
PAN_ACCELERATION_SPEED; }

        // Add forces to ROLL
```

```
		if (key_pgup) { my._FORCE_ROLL += time *
PAN_ACCELERATION_SPEED; }
		if (key_home) { my._FORCE_ROLL -= time *
PAN_ACCELERATION_SPEED; }


		// Decelerate if keys are not pressed.


		if ((key_cul == off) && (key_cur == off) && (abs(my._FORCE_PAN) >
SHIP_CALM_PAN))
		{


			my._FORCE_PAN -= (sign(my._FORCE_PAN) * time *
PAN_DECELERATION_SPEED);


			// Zero out the pan if it's a very small number.  This keeps the ship
from
			// slowly turning if the pan is near zero but not zero.


			if (abs(my._FORCE_PAN) < SHIP_CALM_PAN)
			{
				my._FORCE_PAN = 0;
			}
		}
		if ((key_cud == off) && (key_cuu == off) && (abs(my._FORCE_TILT)
> SHIP_CALM_PAN))
		{


			my._FORCE_TILT -= (sign(my._FORCE_TILT) * time *
PAN_DECELERATION_SPEED);


			if (abs(my._FORCE_TILT) < SHIP_CALM_PAN)
			{
				my._FORCE_TILT = 0;
			}
```

```
		}
		if ((key_pgup == off) && (key_home == off) &&
(abs(my._FORCE_ROLL) > SHIP_CALM_PAN))
		{

			my._FORCE_ROLL -= (sign(my._FORCE_ROLL) * time *
PAN_DECELERATION_SPEED);

			if (abs(my._FORCE_ROLL) < SHIP_CALM_PAN)
			{
				my._FORCE_ROLL = 0;
			}
		}



		// Restrict the roll forces to maximum values

		my._FORCE_PAN = clamp(my._FORCE_PAN, -1 *
TOP_ROTATION_SPEED, TOP_ROTATION_SPEED);
		my._FORCE_TILT = clamp(my._FORCE_TILT, -1 *
TOP_ROTATION_SPEED, TOP_ROTATION_SPEED);
		my._FORCE_ROLL = clamp(my._FORCE_ROLL, -1 *
TOP_ROTATION_SPEED, TOP_ROTATION_SPEED);



		//Used for the rotation
		vec_set(temp.x,my._FORCE_PAN);
		vec_to_angle(temp.pan,nullvector);
		ang_add(temp.pan,my.pan);
		vec_diff(temp.pan,temp.pan,my.pan);

		// Apply the pan/tilt/roll forces to the player's ship
		c_rotate(my,temp.pan,ignore_passents);
```

```
		// Move the ship
		c_move(my, vector(my._FORCE_X, my._FORCE_Y, my._FORCE_Z),
nullvector, glide+ignore_sprites);



		// Check for the fire key and fire missiles if it's pressed.

		if (fire_key_clear == on)
		{
			if(key_ctrl == on)
			{
				ent_create (rocket_mdl, player.x, rocket_action);
				snd_play (rocket_wav, 50, 0);
				fire_key_clear = 0;
			}
		}

		if (key_ctrl == off)
		{
			fire_key_clear = 1;
		}

		view_ship();  // move camera along with ship entity
		wait(1);
	}
	//if player dies execute a death roll
	cd_pause();
	if(my.healthpoints<=0)
	{
	while(my.skill20<500)
	{
			c_rotate(my,vector(1,1,1),IGNORE_YOU &
IGNORE_PASSABLE + IGNORE_PUSH + ACTIVATE_TRIGGER + GLIDE);
```

```
                        my.skill20 = my.skill20+1;
                        view_ship();
                        //don't allow the healthpoint to go below 0
                        if(player.healthpoints<0)
                        {
                                player.healthpoints=0;
                        }
                        wait(1);
                }
                media_play("explo.wav",null,1000);
        }
}

font panel_font = "Arial",1,20;
//displays the life of the player
panel health_panel
{
        pos_x = 0;
        pos_y = 470;
        digits = 30, 30, 4, panel_font, 1, Player.healthpoints;
        layer = 1;
        flags = refresh, visible,overlay;
}

panel crosshair_panel
{
        pos_x = 363;
        pos_y=267;
        bmap = crosshair_bmp;
        layer=1;
        flags = refresh, overlay, visible, transparent;
}
```

```
function radar()
{
	if(player != NULL)
	{
		vec_diff(temp.x,my.x,player.x);
		temp.y=-temp.y;
		vec_rotate(temp.x,vector(player.pan-90,0,0));
		vec_scale(temp.x,0.1);
		if(vec_length(temp.x)<128)
		{
			draw_text("*",temp.x+1524/2,temp.y+1068/2,vector(0,255,0));
			draw_text("*",1524/2,1068/2,vector(0,0,255));
		}
	}
}

function debris_action
{
	var velocity_vec[3];
	var vel_vec_normalized[3];
	var spin_vec[3];
	var count;

	my._TYPE = SPACE_DEBRIS_TYPE;

	count = random(DEBRIS_LIFETIME) + 10;

	velocity_vec.x = (random(2) - 1);
	velocity_vec.y = (random(2) - 1);
	velocity_vec.z = (random(2) - 1);

	spin_vec.x = random(10);
	spin_vec.y = random(10);
```

```
	spin_vec.z = random(10);

	my.passable = 1;

	while(count > 0)
	{
		vec_add(my.pan, spin_vec);
		move_mode = IGNORE_YOU + IGNORE_PASSABLE +
IGNORE_PUSH + GLIDE;

		vec_set(vel_vec_normalized, velocity_vec);
		vec_normalize(vel_vec_normalized, time);

		ent_move(nullvector, vel_vec_normalized);
		count -= time;

		wait(1);
	}

	small_explosion(handle(my));

	wait(1);
	ent_remove(my);

	wait(1);
}

function explosion_fade()
{
	my.alpha -= 20 * time;
	if(my.alpha < 0)
	{
		my.lifespan = 0;
```

```
	}
}

function small_explosion_particle
{

	var velocity_vec[3];

	velocity_vec[0] = random(4) - 2;
	velocity_vec[1] = random(4) - 2;
	velocity_vec[2] = random(4) - 2;

	vec_set(my.vel_x, velocity_vec.x);

	my.move = on;

	my.bmap = explosion_particle_map;

	my.alpha = 80;
	my.lifespan = 100;
	my.size = 10;
	my.flare = 1;

	my.function = explosion_fade;

}

function explosion_particle
{

	var velocity_vec[3];

	velocity_vec[0] = random(14) - 7;
```

```
	velocity_vec[1] = random(14) - 7;
	velocity_vec[2] = random(14) - 7;

	vec_set(my.vel_x, velocity_vec.x);

	my.move = on;

	my.bmap = explosion_particle_map;

	my.alpha = 80;
	my.lifespan = 100;
	my.size = 45;
	my.flare = 1;

	my.function = explosion_fade;

}

function explosion(entity_handle)
{

	var pos_vec[3];
	var count = 20;

	ent_pointer = ptr_for_handle(entity_handle);

	if (ent_pointer != null)
	{
		vec_set(pos_vec, ent_pointer.x);

		pos_vec.x += (random(12) - 6);
		pos_vec.y += (random(12) - 6);
		pos_vec.z += (random(12) - 6);
```

```
	}

	while (count > 0)
	{
		effect(explosion_particle, 2, pos_vec.x, nullvector);
		count -= 1;
	}

	// set debris count
	count = 5;

	while (count > 0)
	{
		ent_create("debris1.mdl", ent_pointer.x, debris_action);
		count -= 1;
	}

	wait(1);
}


function small_explosion(entity_handle)
{

	var pos_vec[3];
	var count = 10;

	ent_pointer = ptr_for_handle(entity_handle);

	if (ent_pointer != null)
	{
		vec_set(pos_vec, ent_pointer.x);
```

```
            pos_vec.x += (random(6) - 3);
            pos_vec.y += (random(6) - 3);
            pos_vec.z += (random(6) - 3);
        }

        while (count > 0)
        {
            effect(small_explosion_particle, 2, pos_vec.x, nullvector);
            count -= 1;
        }
}

action patrol_path
{
        //              AI for the enemy ship
        // 1. The ship will patrol until the player is spotted
        // 2. Once the player is spotted, the ship will stop patrolling
        //    and attack the player.
        // 3. Anytime the player is out of view after they've been spotted,
        //    the enemy ship will use path finding to move toward the player.

        // Set the _TYPE.  This is an identifier that's used in the events code
        // to help specify what actions should be taken during, say, and event_entity.

        my._TYPE = ENEMY_TYPE;

        my.enable_impact = on;
        my.enable_entity = on;
        my.enable_scan = on;

        my.event = enemy_event;

        my.healthpoints = 30; // and I have 30 health points
```

```
// The new player_spotted flag will indicate wether the player has been detected
// by the enemy.  If not, the enemy will patrol until the player is spotted.  If
// the player has been spotted, then instead of patrolling, the enemy will use
// the pathfinding algorithm to navigate toward the player.

var player_spotted = 0;

// Turn speed with be the turning radius of the enemy ship while it's using
// pathfinding.

var turn_speed;

/*
my.narrow = on;
my.fat = on;
c_setminmax(my);
*/

var RELOAD_TIME = 20;              // Time between shots
var sleep_counter;

var node_pos[3];                   // temp storage for node position in AI
var node;                                    // current node
var dist;                                    // distance to node

var direction_vec[3];            // Used to prepare arguments to pf_smooth_turn()

while(player == null)
{
        wait(1); //used to keep from getting a null pointer to player
}
```

```
//Patrol path for the enemy ship
// attach entity to nearest path
node = path_scan(me, my.x, my.pan, vector(360,180,1000));

if (node == 0)
{ // no path found
	beep(); //for debuging
	return;
}

// find first waypoint
path_getnode(my,node,node_pos.x,null);

while (my != NULL)
{
	//if enemy lost health even if it did not trace the player
	//activate player_spotted
	if(my.healthpoints<30)
	{
		player_spotted = 1;
	}

	//continue patroling until player is spotted
	//or sound_alarm is activated

	if ((! player_spotted) && (! SOUND_ALARM))
	{
		// find distance
		dist = vec_dist(node_pos.x,my.x);

		// near target? Find next waypoint of the path
	if (dist < 25)
		{
```

```
                        node = path_nextnode(my,node,1);
                        path_getnode(my,node,node_pos.x,NULL);
                }
        }

        radar(); //this is used to display a radar in the player's ship


//this sets the you to the player if visible.
        trace_mode = IGNORE_ME + IGNORE_PASSABLE +
ACTIVATE_TRIGGER + use_box;
        trace(my.x,player.x);

        //if player is close to me and player is alive
        if (player.healthpoints > 0 && (you == player))
        {
                //it will now start pathfinding to find the player
                player_spotted = 1;

                //this jams the players radar so the enemy can't  be seen
                draw_text("JAMMED",1400/2,1068/2,vector(255,100,100));

                //initial rotate values to rotate toward the player
                vec_set(temp, player.x);
                vec_sub(temp, my.x);
                vec_to_angle(my.skill2, temp); //store angle in skill 2, 3

                //while I am not facing at player, turn toward player
                while(abs(ang(my.skill2)-ang(my.pan))>1 || abs(ang(my.skill3)-
ang(my.tilt))>1)
                {

draw_text("JAMMED",1450/2,1068/2,vector(255,100,100));
```

```
                vec_set(temp, player.x);
                vec_sub(temp, my.x);
                vec_to_angle(my.skill2, temp); //store angle in skill 2, 3
                my.pan -= ang(my.pan-my.skill2)*0.5*time; //0.5 = speed
                my.tilt -= ang(my.tilt-my.skill3)*0.5*time; //0.5 = speed
                //                      c_rotate(my,temp,ignore_passents);
                wait(1);
        }
        //used for testing
        //if started with command line parameter
        //"-d no_enemy_fire" enemies don't fire
        ifndef no_enemy_fire;

                ent_create(bullet_red,my.x,shoot_action); //fire at player

        endif;

        //used to pause in between shots
        sleep_counter = 0;
        while((sleep_counter < RELOAD_TIME) && (my.healthpoints >
0))
        {
                sleep_counter += time;
                wait(1);
        }

}

//continue patrol
else
{
        if ((! player_spotted) && (! SOUND_ALARM))
        {
```

```
                        // Patrol...

                        vec_set(temp, node_pos.x);
                        vec_sub(temp, my.x);
                        vec_to_angle(my.skill10, temp);

                        my.pan = my.skill10.pan;
                        my.tilt = my.skill11.tilt;

                        temp.x = 5 * time;
                        temp.y = 0;
                        temp.z = 0;

                        c_move (my, temp, nullvector, IGNORE_YOU +
IGNORE_PASSABLE + IGNORE_PUSH + ACTIVATE_TRIGGER + GLIDE);
                }
                else
                {
                        // Pathfind...

                        dst_ent = player;

                        //the two arguments are the two points that the pathfinding
algorithm uses
                        //as a start and end point
                        if ( pf_to_ent(my, dst_ent) )
                        {
                                //Turn toward the next node
                                turn_speed = 15 * time;

                                direction_vec.pan  = my._PF_PAN_TO_TARGET;
                                direction_vec.tilt = my._PF_TILT_TO_TARGET;
```

```
                                        direction_vec.roll = my._PF_ROLL_TO_TARGET;



                                        //if "PATH_SMOOTHING" is enabled
                                        if (PATH_SMOOTHING)
                                        { //smooth path
                                                pf_smooth_turn(my,
VECTOR(my._PF_PAN_TO_TARGET, my._PF_TILT_TO_TARGET,
my._PF_ROLL_TO_TARGET), turn_speed);
                                        }
                                        else
                                        { //use a rough turn
                                                vec_set(my.pan, direction_vec.pan);
                                        }

                                        // If the entity has NOT reached the target entity,
then move toward it.

                                        if(my._PF_REACHED_TARGET == 0)
                                        {
                                                //ignore the entity nodes
                                                move_mode = IGNORE_PASSABLE +
GLIDE;

                                                ent_move(vector(time * 15,0,0), nullvector);
                                        }
                                }
                        }
                }

                //if I am dead

        if(my.healthpoints <= 0)
                {
```

```
                media_play("explo.wav",null,1000);

                explosion(handle(my));
                small_explosion(handle(my));

                my.invisible = 1;
                my.passable = 1;

                sleep(2);

                ent_remove(me);
            }

        wait(1);
        }
}
```

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